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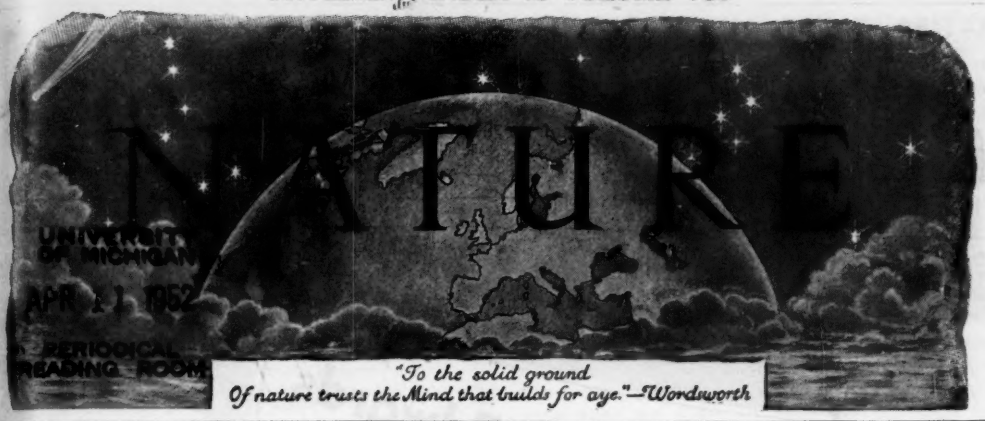
SUPPLEMENT: INDEX TO VOLUME 168



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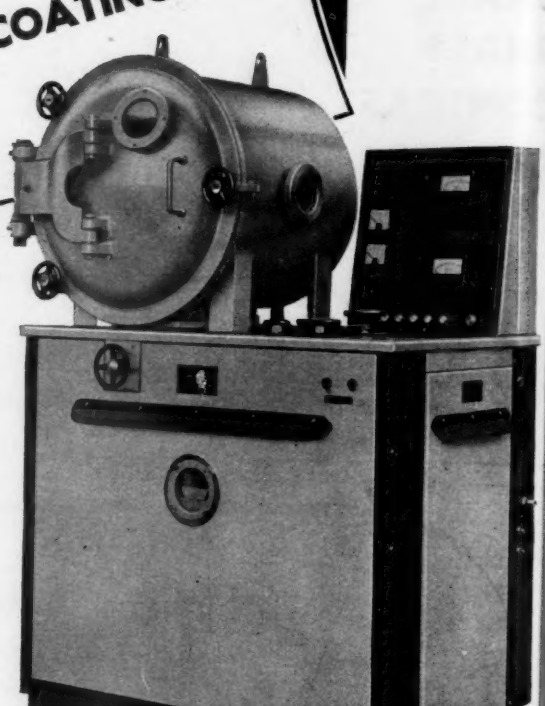

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NATURE

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UNIVERSITIES IN GREAT BRITAIN

TAKEN together, the interim report from the University Grants Committee on university development during 1947–51*, and the written reply of the Chancellor of the Exchequer on February 21 regarding recurrent grants to the universities of Great Britain for the next quinquennium, should dispose of most of the fears as to the effect of the present economic stringency on university development. During the past five years the number of university students has increased by 70 per cent above the pre-war level—from about 50,000 to about 85,000—while the number of students in science and technology was virtually doubled by 1947, instead of in the ten years contemplated by the Barlow Committee on Scientific Man-power in 1946. At the same time the academic staff has increased from 3,994 in 1938–39 to 8,490 in 1950–51, and some £17 millions worth of new buildings have been completed. Inconveniences of overcrowding have been willingly endured in the hope that a rapid increase in the rate of university building would soon become possible.

The Chancellor's statement holds out no prospect that that hope is likely to be realized in the near feature : speaking of non-recurrent grants for capital expenditure, Mr. R. A. Butler could only add that, so long as it remained necessary to control the distribution of building work through the investment programme and the licensing system, no long-term assurances could be given as to the amount of building work which the universities could undertake. Provision will continue to be made annually in accordance with the general investment policy, but Mr. Butler undertook to consider whether he could, at a later stage, give any useful guidance to the universities as to the scale on which they should frame their long-term plans.

Some such guidance will clearly be necessary when the Government decides on its policy in regard to higher technological education—a matter on which the present report adds nothing to the "Note on Technology in Universities" which the University Grants Committee issued in December 1949. For the rest, however, while the Committee seems to be satisfied with the general quality of the students entering the universities, and that in most institutions the difficulties inherent in the selection of students are being recognized and faced, the general conclusion is reached that no further substantial increase in student numbers could be expected in the immediate future without lowering university standards. This interim review of a quinquennium of expansion points to the following quinquennium as likely to be one essentially of consolidation and adjustment rather than expansion.

The Chancellor's statement is in the same sense. The total recurrent grant of £16·6 millions in the present year is to rise to £20 millions in 1952–53 and thereafter by £1 to £1·5 millions each year to £25 millions in 1956–57. Rising costs would make it impossible for the universities to maintain their

* University Grants Committee. University Development : Interim Report on the Years 1947 to 1951. (Cmd. 8473.) Pp. 28. (London : H.M. Stationery Office, 1952.) 1*s.* net.

existing activities on the present grant, apart from the fact that in future new furniture and equipment for accommodation in use will have to be provided from the recurrent and not from non-recurrent grants. Moreover, the uneven age-distribution of the teaching staffs is likely to magnify the effect of the increases in academic salaries which were approved and made possible by Exchequer assistance in the last three years of the quinquennium. Nevertheless, Mr. Butler hoped that the increases in the later years of the new quinquennium would permit some new developments, particularly in science and technology. Whether such expansion is possible with the grants announced depends, of course, very largely on the extent to which the Chancellor succeeds in halting the rise in costs.

The increase in student numbers was not spread evenly over the universities and colleges. In England, for example, where the increase over 1938–39 was 71·5 per cent in 1950–51, it was only 43·5 per cent and 33 per cent at Oxford and Cambridge, respectively, where possibilities of expansion in the colleges were limited, and only 40 per cent in the University of London. In other English universities and university colleges the increase averaged 123 per cent; in Wales it was 85 per cent, and in Scotland, where numbers were relatively high before the War, it was 60 per cent. In the faculties of science and technology there has been only a small increase in the number of outstandingly able students, and the report estimates that, in relation to the total number of students, the proportion of very good and very weak students is lower, and that of good second-class students higher than it used to be. In the arts faculties, where numbers had risen by 57 per cent by 1947, the number of really first-class men and women seems to be slightly smaller than before the War, and there is probably a continuing tendency for a higher proportion of the abler candidates to seek admission to the faculties of science and technology. In medicine, a general improvement in the quality of students is attributed to the wider field from which entrants are now drawn.

Pointing out that the proportion of total Exchequer grants to the total income of the universities has now risen from 35·8 per cent in 1938–39 to 63·9 per cent in 1949–50, and will rise still further, the University Grants Committee indicates that it is still exercised over this growing dependence, which it stressed in its last report three years ago. While it concludes emphatically that, in its judgment, the sums which Parliament has provided during the present quinquennium have been expended judiciously and in a manner conducive to the public interest, the present report is obviously intended only as an introduction to the subsequent fuller report which will provide the material for independent judgment concerning the expenditure of these unprecedentedly large sums of public money. The Committee is not at present disturbed at this dependence on public support; but it reiterates its objection to the device of ear-marking grants for particular purposes. While through the system of sub-committees established for the purpose the device has worked well and has secured the rapid initiation of developments judged necessary in the national interest, the Committee is strongly of the opinion that, as soon as a satisfactory level of development has been reached in any of the special fields, the relevant ear-marked grants should be absorbed in the general block grants. The system does not interfere with the freedom of the universities; but it does restrict their own determination of the proper balance between the faculties.

Of these ear-marked grants the largest, rising from £1,840,350 in 1947–48 to £3,198,500 in 1951–52, was for the reform and re-organization of medical education, although in accordance with the view of the Goodenough Committee the number of undergraduate medical students was not increased. Grants rising in 1951–52 to £300,000 were set apart for dental education, where the present entry of 600 is well below the 900 recommended by the Teviot Committee, to £361,600 for agricultural education, where the number of students has risen from 1,043 in 1938–39 to 2,606 in 1950–51, and to £412,500 for veterinary education; and for oriental, African, Slavonic and East European studies grants totalling in 1951–52 the £250,000 a year suggested by the Scarborough Interdepartmental Commission has now been allotted. Similar special grants rising from £102,000 in 1947–48 to £400,000 in 1951–52 were also made to assist developments in the social sciences, and those for the establishment of institutes of education have likewise risen from £20,230 to £171,463. The report also lists the selected science subjects for which special grants have been made to certain universities to finance developments in fields which appeared to have been covered inadequately. In this attempt to secure the even development of scientific research, the universities have been most co-operative, and there has been no suggestion that the University Grants Committee has forced on them the adoption of projects which they found unwelcome.

The report thus appears to warrant the conclusion that, through the medium of the University Grants Committee, it has thus far been possible to guide the expansion and development of the universities of Britain along the lines which seem to be most desirable in the national interest, without either impairing the autonomy of the universities or distorting the balance of studies by excessive compliance with particular sectional interests. It would seem, however, that further thought is needed as to the purposes and functions of a university; and this applies particularly to the arts side, where expansion has been achieved, broadly speaking, without the assistance of special grants. Clearer ideas as to such purposes and functions bear closely, too, on both the problems of selection of students for admission and the policy to be adopted in regard to halls of residence, in which relatively little progress is reported.

In spite of an increase of some 7,000 in the numbers of places in halls of residence, a smaller proportion of students is, in fact, living in halls than before the War. A few new halls have been or are being erected, and various devices have been used to increase the number of places in existing halls; but the Committee itself estimated in its last report that to pro-

vide such accommodation for only half the present student population would involve a new building programme costing at least £50 million. This was recognized as impracticable even in 1947, and when the Committee estimated that the total needs of the universities would require expenditure during the quinquennium of £40 millions on new buildings and £10 millions on the purchase of sites and equipment at building prices then ruling, the Chancellor of the Exchequer in accepting the estimate predicted that more than £20 millions of building was improbable during the period. In the event, expenditure by university institutions on new building during the three calendar years 1948–50 was just under £8 millions, and the application of the limited building resources available in the best interests of the universities as a whole has become an increasingly difficult and invidious task for the University Grants Committee.

Here again good sense and sympathetic understanding on both sides has made the arrangement workable, even if it has been impossible to prevent some deterioration in the standards of accommodation. On the evidence of this report there is every reason to hope that the University Grants Committee will continue in the future, as it has done in the past, to secure the wise expenditure of the large sums now entrusted to it, and to foster the developments most desirable in the public interest without impairing in any way the freedom or autonomy of the universities. While many of the hopes entertained at the beginning of the quinquennium have remained unfulfilled, even on the capital side a beginning has been made with the heavy task of putting the housing of the universities on a satisfactory permanent basis, and the non-recurrent capital grants have already permitted the purchase of the sites which will be needed. Meanwhile, there are other ways besides the adjustment of academic salaries and improvement of staff–student ratios and resources for research in which the universities can consolidate their position and adjust or improve standards. When the fuller review of the Committee appears in due course, it will doubtless deal also with such matters as laboratory technicians, library resources and laboratory equipment, all of which, like adequate building and accommodation generally, contribute to the maintenance of standards and the service of efficiency and quality which, rather than quantity, the University Grants Committee clearly recognizes as the right policy. Nor should that review of future policy fail to give fresh consideration to the purposes and functions of the universities in national life to-day. Without clear ideas as to those purposes and functions, it is impossible either to assess rightly the appropriateness of sectional demands for vocational education, or to determine the relation of the universities to the educational system of the country as a whole. Any such review must include both their extra-mural activities and the way in which they might help to meet such needs as have been emphasized in the reports of recent 'productivity teams' of the Anglo-American Council on Productivity in regard to the education of managers and technicians.

SCIENCE AND GOVERNMENT

Reflections on the Constitution

The House of Commons, the Cabinet, the Civil Service. By Harold J. Laski. Pp. 220. (Manchester: Manchester University Press, 1951.) 12*s*. 6*d*. net.

THESE "Reflections" are the unrevised text of three public lectures which Prof. H. J. Laski delivered in the University of Manchester a few weeks before his death on March 25, 1950. They are largely a reply to some contemporary criticisms of Parliament, especially to the protagonists of national or functional devolution, and much of the book is a reasoned criticism of Mr. L. S. Amery's "Thoughts on the Constitution". In substance the book stoutly champions the current role of Parliament, or rather of the House of Commons, in the quality of which Prof. Laski firmly believed, as well as in its capacity to rise to the occasion, either in discussion or in asserting its authority over the executive when some great principle is at stake. The reasoned statement of his views is interspersed with comments from personal experience or observation which give the book much more than a theoretical interest, and also provide an interesting revelation of the development of Laski's own thought with its curious blend of percipience and obtuseness. He defended, for example, recommendations of the Haldane Committee regarding the organization of the Cabinet, though he recognized the weaknesses of some of the Haldane proposals and conceded that something—and perhaps much—must be left to the predilection of a Prime Minister. To the dangers of delegated legislation or of party tyranny he is strangely, even wilfully, blind, and there is little hint in this book of the value of individual liberty or initiative as opposed to administrative convenience. 'Conform or perish' is his doctrine, and nowhere is there a hint that Laski saw that the ultimate issue is one which transcends differences between parties or sections—the issue between the temper and spirit of accommodation and the temper and spirit of intransigence of which Sir Ernest Barker wrote in his great book. For proportional representation he had no use, and his case is well argued. Less convincingly, he was unconcerned with the decline of the independent or private member. He leaned strongly to the device of the advisory parliamentary committee, and added his voice to those of others who urge that much careful thought is required about parliamentary control of the nationalized industries. He is at his best, however, where he deals with the Civil Service, and especially with the problems that arise in the use of the scientific or other technical expert. Here, in the passages which are of most interest to the scientific man, the book is not tendentious, and Laski's remarks on the place of research and on the failure of the Civil Service to develop means for making the most effective use of scientific advance provoke thought and deserve to be widely read.

A passage in which Prof. Laski discusses the proposals Mr. Amery advanced in 1945, for a small policy-making Cabinet consisting of Ministers free from departmental responsibility, and the practical difficulties which arise both in co-ordination and in relating policy and executive action, bears closely on the suggestion which Lord Cherwell made last July regarding the responsibility for the development of atomic energy. Prof. Laski argues cogently that in such matters as atomic energy our chances of arriving

at sound decisions as to future policy would not be enhanced by any separation of Ministers who determine policy from Ministers who are concerned with the details of administration in particular departments of government. Here at least Prof. Laski recognized that men are more important than organization. Ministers must be competent to separate essentials from non-essentials and to avoid becoming so immersed in detail that they cannot find time to review basic principles of policy. Just as the university teacher is at his best when he combines teaching with research, so the Cabinet Minister is most effective when his planning or policy-making is combined with continual experience in actual administration and execution of policy.

For this reason Prof. Laski suggests that the most important feature of Mr. Amery's proposals for the Cabinet is not this separation between the making and the execution of policy, but the distinction drawn between long-range policies based upon research and reflexion over prolonged periods and policies which have to be determined immediately to enable swift action to be taken to meet some emergency. Research that is to affect immediate policy must obviously be controlled by those who are directing that policy, and where some of that research must be carried out by specialists they must be in the closest possible touch with the Civil servants engaged in the administration which that research is to serve. The contact should be of the type with which the participants in operational research were familiar during the Second World War, in which each side is constantly influenced and stimulated by ideas and needs made known by the others.

In contrast to this, the research carried out by such bodies as the Department of Scientific and Industrial Research, the Agricultural Research Council, the Medical Research Council, and the Central Statistical Office, is completely detached from the making of policy, at least to the extent that such bodies have no direct responsibility for what is done with the results of their inquiries. The distinction is important and is one that is commonly overlooked. Where, for example, the investigations carried out under such bodies or at the universities themselves lead to results which could be utilized with great public advantage, the responsibility for securing action is one that rests on the individual or on a professional group, and such action will be taken through the usual political channels without being mixed up with the pursuit of science itself. The place for the specialist, Prof. Laski rightly insists, is not at the point where the Cabinet Minister translates his principles into policy or administration.

Laski recognized the necessity for the combination of the findings of the expert with an imaginative insight into men and women if a successful policy is to emerge, and also suggested that no administrator could apply policy creatively unless he was profoundly aware of the philosophy which underlies and impels the decision it is his business to implement. His main criticism of the Civil Service is, in fact, that, particularly between the World Wars, it was deficient in just that respect; it lacked imagination and insight as well as enterprise, particularly where science and technology were concerned; at its higher levels, its work in the Second World War was in consequence far less creative than in the First. He also discusses the position of the scientific worker, notably the importance of wider recruitment to the administrative class from men and women of mature and varied experience outside the Service, of wider and freer contact with the Civil servants of other countries, as well as of greater mobility within the Service itself, including promotion of promising men from the executive class and the discovery of unused talent. He held to the last his belief that science could be planned or co-ordinated, and advocated a Central Committee for Scientific and Technological Research under which the existing research bodies would work; but he ignored the practical difficulty of finding those competent to make an overall judgment of the relations of science to national needs. He also overlooked the extent to which the recommendations of the Barber Committee on Scientific Man-power have already been implemented. Nevertheless, his suggestions regarding operational research and the imperative and urgent importance of making the ordinary citizen aware of what science means and its significant part in our lives illustrate Laski's own awareness of such matters, and that the world of science in his death has lost a shrewd critic and a tireless, if not always a tactful or unbiased, advocate.

R. Brightman

ATMOSPHERIC OZONE

L'Ozone atmosphérique

Par Charles Fabry. Pp. 278. (Paris: Centre National de la Recherche scientifique, 1950.) n.p.

SCHÖNBEIN of Basle in 1840 gave ozone its name, referring to its odour—long known as the 'electric' odour and well recognized in the 1780's. Gradually its oxygen triatomic construction came to light; and after liquid air became easily available, it was obtained in the pure state and found to be a blue gas. Its presence in the atmosphere was established by Houzeau in 1858.

Cornu in 1879, after much observation and experiment, concluded that the observed limit of the solar spectrum is due to absorption in the atmosphere by some permanent constituent of the air. In 1881 Hartley discovered the truly remarkable absorptive power of ozone for ultra-violet light; he suggested that ozone is the constituent that Cornu had envisaged, and that it is more concentrated in the upper atmosphere than near the ground. From 1912 onwards this hypothesis was step by step confirmed by the brilliant spectroscopic investigations of Fabry and Buisson, supported by those of Fowler and Strutt (later Lord Rayleigh).

Fabry continued throughout the rest of his long life to be keenly interested in atmospheric ozone; he also stimulated the interest and varied efforts of many eminent pupils and others in the same field. He himself showed how to determine both its total amount in any vertical column of atmosphere and its vertical distribution.

In his later years he set out to expound the subject of atmospheric ozone in a systematic monograph. He completed the greater part of it, covering the developments up to 1942. In 1945 he died, leaving the text in manuscript, but without listing the diagrams or the bibliography.

One of his pupils, Mme. Arlette Vassy, herself a distinguished investigator in the subject, undertook the considerable task of preparing the work for publication. The gratitude of the readers of the monograph, now issued with a preface by Dr. J. Cabannes, will go not only to the late author but

also to Mme. Vassy, for this act of devotion to his memory, which ensures that this *chef d'œuvre*, as Dr. Cabannes rightly calls it, is made available to the world.

The book begins with an admirable historical chapter; then the properties, production and chemical determination of ozone are described. The next three chapters deal with its optical properties of absorption, and their use in its analysis and measurement; they are affected by the density, the temperature and the presence of other gases. Despite subsequent technical advances, these chapters will be very helpful to later workers on atmospheric ozone, for their beautiful exposition of the principles involved and of the present considerable range of proved experimental and observational data.

Then follow two chapters on the general geophysical aspects of ozone (its distribution over the earth, at different heights, its seasonal and 'weather' variations, its temperature) and its biological influences. The concluding chapter, dealing with the theoretical side of the subject, is the weakest part of the book.

The bibliography seems to contain no reference later than 1942; but, with the reservation just implied, the book is an excellent record and guide to the state of our knowledge of atmospheric ozone up to that date.

HOMOGENEOUS CO-ORDINATES

General Homogeneous Coordinates in Space of Three Dimensions

By E. A. Maxwell. Pp. xiv+169. (Cambridge: At the University Press, 1951.) 15*s*. net.

THERE are many books on analytical geometry of three dimensions; but few deal with it from the projective point of view, and these few are only suitable for advanced students. Dr. E. A. Maxwell provides a short and comparatively simple introduction to the subject, suitable for second-year undergraduates who in their first year have read the author's "The Methods of Plane Projective Geometry based on the use of General Homogeneous Coordinates".

The first six chapters are exclusively projective, and do not use the ideas of length or angle. Chapter 1 deals with the point, straight line and plane. Chapter 2 deals with the quadric surface, and Chapter 3 with its generators. Chapter 4 introduces line geometry, including the linear complex and congruence, the regulus, and the tetrahedral complex. Chapter 5 gives the principal properties of the twisted cubic, omitting the somewhat tedious detail which would be required in a complete treatment. Chapter 6 deals with systems of quadrics in the cases which arise most frequently. Chapter 7 links up the projective ideas of the preceding chapters with Euclidean geometry by means of the 'plane at infinity' and the 'absolute conic' in this plane. The metrical properties discussed from this point of view include those of confocal quadrics and normals to quadric. Finally, Chapter 8 gives a lucid and useful short introduction to matrices, intelligible to those with no previous knowledge of them, and gives also some of their geometrical applications, including several results on line co-ordinates which simplify previous treatments.

One distinctive feature of this valuable book is that the text includes a fairly large number of theorem-examples, which are standard results, following directly from the preceding work. The student is informed that the conscientious solution of these examples is an essential part of the reading of the book. Short hints have been added to remove any likely difficulty. At the end of each of the first five chapters there are easy examples of the usual kind, while all chapters except the last have sets of miscellaneous examples which are much harder, many taken from Part 2 of the Cambridge Mathematical Tripos. The book concludes with a set of twenty-three hard general examples, answers to the examples, and an index. H. T. H. PIAGGIO

STATISTICS FOR CLASSES AND MASSES

Introduction to Statistical Method

By B. C. Brookes and W. F. L. Dick. Parts 1 and 2. Pp. viii+288. (London: William Heinemann, Ltd., 1951.) 21*s*. net.

Facts from Figures

By M. J. Moroney. (Pelican Books, A.236.) Pp. viii+472. (Harmondsworth: Penguin Books, Ltd., 1951.) 5*s*.

ALMOST simultaneously with the Royal Statistical Society's report on "The Teaching of Statistics in Schools" is published the first text-book of modern statistics planned for and suitable for school use. In an "Introduction to Statistical Method" B. C. Brookes and W. F. L. Dick have succeeded well in a difficult task, though in places they do not emphasize sufficiently the manner in which the interpretation of data must be governed by the source and the method of collection. Their first six chapters (which are available separately) provide a course adequate for most of the statistics papers now set for the General Certificate in Education; the remaining five would give a more advanced pupil an excellent foundation for eventual university specialization in statistics, yet without demanding much mathematical knowledge. Much more important than this examination or vocational training, however, is the presentation of statistics as a branch of scientific method that can assist many other school studies. The examples used are especially valuable in showing statistical science at work and in suggesting 'live' practical exercises connected with both laboratory sciences and everyday affairs.

M. J. Moroney in "Facts from Figures", which is published in a series that has established a remarkable reputation for large sales in spite of titles that suggest very limited popular appeal, has made an even more ambitious attempt to improve the public consciousness of the function of statistics. He states that his intention is "to take the reader on a conducted tour of the statistician's workshop" so that "after watching the craftsman for a while, he may try for himself". At times Mr. Moroney's enthusiasm may seem to leave the reader machine-minding when he might more profitably admire the view from the window: the chapters on quality control, for example, contain an excessive amount of detail of technique, more suited to a manual of instruction than to a conducted tour, and the discussion of sampling is somewhat narrowly confined to industrial applications. Nevertheless, this enthusiasm has produced a

stimulating book, betraying at times the author's prejudices and (by some errors) the speed with which it was written, but encouraging the reader to persevere and presenting difficult ideas with an effective style. Mr. Moroney is no doctrinaire theorist, but an exponent of methods that he has proved valuable in problems of industry and science; his book is packed with wise advice on the collection and interpretation of data, all of which is at least as important as the information on analysis. If the book has the wide currency that it deserves, it should do much to forward his contention that: "Whoever you are, if your work calls for the interpretation of data, you may be able to do without statistics, but you won't do so well".

D. J. Finney

THE LOGIC OF INDUCTION

A Treatise on Induction and Probability

By Prof. Georg Henrik von Wright. (International Library of Psychology, Philosophy and Scientific Method.) Pp. 310. (London: Routledge and Kegan Paul, Ltd., 1951.) 30*s*. net.

THE author puts forward this work somewhat diffidently as a contribution to the problem of induction, which since the days of Hume has presented a challenge to philosophers. The general title of the book is a little misleading, for Prof. G. H. von Wright intentionally restricts his discussion to the logic of inductive inference, as distinct from the problems of discovery and justification. To this end he introduces the methods of symbolic logic in Chapter 2, and discusses the logic of inductive truth in the following chapters. These include a chapter on the relation with deduction, in which the author considers the supplementary and often suppressed premises required to render induction demonstrative. In the second half of the book he goes on to discuss the logic of inductive probability, introduced in Chapter 7 by an axiomatic development of probability logic. He adds here a fairly complete list of the various possible interpretations of probability, though for the frequency interpretation he seems to be most familiar with the direct definitions of von Mises or Reichenbach. Many statisticians, including myself, prefer the relation with frequency to be made finally precise by the theoretical laws of large numbers. For example, need a sequence defining a probability value be completely random? The probability calculus itself tells us that the answer is no; all that is required is that the sequence should be ergodic.

The carefully limited aim of this book disarms criticism, for the author is an acknowledged expert on inductive logic; it can nevertheless be occasionally irritating. The author often shows his awareness of problems, difficulties or alternative approaches, only to dismiss them as lying outside his chosen field. This isolation of one's subject-matter is admissible up to a point, but seems dangerous with the problem of induction, which is linked so inextricably with other philosophical problems, such as causality and the nature of scientific laws. The author distinguishes two kinds of induction: those of the first order or predictions, and those of the second order or theories. He mentions statistical laws, but does not claim to discuss them at length. Yet Eddington has suggested that, apart perhaps from statistical laws, the laws of Nature are epistemological in character and purely deductive. Again, von Wright adopts as one of his basic axioms in Chapter 2 that every proposition is true or false. Are scientific laws true or false, or merely instruments of prediction of greater or lesser success? And what of three-valued logic—truth, falsehood and indeterminacy—which Reichenbach has claimed avoids causal anomalies in quantum mechanics? Such queries may be answerable (there is, for example, some relevant discussion in Chapter 6 on the inter-relation of induction and definition), and in any case do not affect the validity and permanent value of von Wright's logical analysis. But they do perhaps support the reviewer's, and apparently also the author's, view that a discussion on such classical logical lines may be unduly limited.

This book seems to be intended for professional logicians, who will find in it much acute argument, rather than for general readers, among whom I would class myself. My own inclination would have been to defer such a strictly logical discussion until a more complete general discussion had been attempted, in order to avoid the danger of (to quote the author's own words) "oversimplification and . . . the assimilation of cases to general patterns which they do not really fit". For comparison, the discussion of induction and probability contained in Bertrand Russell's work "Human Knowledge" is for the layman much more readable. Incidentally, von Wright is a little unlucky that his book was completed in 1948, just as Russell's book was published; and he is only able to refer to it (and also to recent work by Carnap) in his final paragraphs.

M. S. Bartlett

A STUDY OF CHORDATES

Vertebrate Zoology

An Introduction to the Comparative Anatomy, Embryology and Evolution of Chordate Animals. By Dr. G. R. de Beer. (Text-Books of Animal Biology.) New edition. Pp. xv+435. (London: Sidgwick and Jackson, Ltd., 1951.) 32*s*. 6*d*. net.

NEARLY a quarter of a century has elapsed since Dr. G. R. de Beer, then a young lecturer in the Oxford Department of the great E. S. Goodrich, published the first edition of his "Vertebrate Zoology", and it has since become one of the foremost introductory text-books in British countries. It has become so with good reason. The book sets out briefly and with great lucidity the essential morphology, embryology and comparative zoology of the various chordate types that all of us studied in our first enthusiastic plunge into the discipline of formal biology.

This new edition, as with the various impressions of the last, deals first with morphological types (including *Ceratodus*); secondly with the four usually used embryological types; thirdly (in the form of a series of short essays) with the comparative zoology of structures such as the skin, fins and limbs, the alimentary system and so on; and fourthly with aspects of evolutionary morphology, including a short separate account of the evolution of the Primates. There is an excellent short chapter on the origin of the Chordates. Finally, there is a classification of the animals previously dealt with.

The chapters dealing with the introductory morphology, embryology and comparative anatomy are admirable, and the illustrations, labelled with

great clarity and judgment, are in keeping with the text. Along with the author's own delineations it is a pleasure to see the retention of some of the historic figures of Jenkinson. To read this book, too, is to realize how much we owe to Goodrich, to whose work and personal influence Dr. de Beer gives full acknowledgment.

Certain chapters, notably those dealing with the brain and comparative behaviour, the special senses, the endocrine organs and the alimentary and other systems, must arouse that contentious subject: How much physiology should we include with our morphology in text-books of this kind? There are many who still believe that a "Vertebrate Zoology", inevitably with an essentially morphological approach, should ignore function or at least keep a consideration of it to a minimum. The present reviewer does not belong to this school and feels that Dr. de Beer has missed in the new edition a great opportunity to lay a little greater stress on what happens within the organs and organisms that he so admirably describes and depicts. A statement such as "little is known of the functions of the [adrenal] gland" rings a little odd in 1952 despite the exigencies of space and the present high cost of the materials of book-making.

However, that is merely a point of view and one which it would be impertinent to stress in view of the sub-title of the work in question. It is a great personal pleasure to have, in improved type, the new edition of a work that one consulted with enjoyment and profit when a student at the other side of the world.

A. J. MARSHALL

WILD-LIFE PROBLEMS IN NEW ZEALAND

Introduced Mammals of New Zealand

An Ecological and Economic Survey. By K. A. Wodzicki. (Department of Scientific and Industrial Research, Bulletin No. 98.) Pp. x+255+14 plates. (Wellington, N.Z.: Department of Scientific and Industrial Research, 1950.) 12*s*. 6*d*.

IN primitive lands wild animals reach a sort of long-term agreement with their surroundings, which is violently upset in many ways by the intrusions of civilization. Into the native and unique island fauna of New Zealand, with its absence of mammals, there have been set free at various times and for various reasons fifty-three species of foreign mammals and a hundred and twenty-five bird species, and these have found conditions of existence and of untried competition so easy that thirty-four mammals and thirty-one birds have become more-or-less permanent residents in the new country. They have set up a series of vegetational, faunal, and economic reactions which are by no means at an end and which pose the problems discussed, so far as mammals are concerned, in this book.

The introductions themselves show how slowly the idea dawned that problems were being created. Neither the native dog and Fiji rat, brought by the Maoris, nor Capt. Cook's domestic animals, set free as a potential food supply, suggested moderation, since they remained localized. So white settlers and their acclimatization societies, for reasons first of food supply, sentiment and amenity, and later for sport or profit, sought particularly in the years between 1860 and 1880 to transform the New Zealand scene into a sort of replica of the 'old country', and brought from Britain more than half the animals which succeeded in establishing themselves. Yet it was not until 1895 that the introduction of "any animal or bird whatsoever" was prohibited except with the written consent of the Minister of Agriculture; and since impacts upon different human interests were recognized at different times, control of wild life in New Zealand is now dispersed between seven government departments, twenty-seven acclimatization societies (originally formed to encourage importations), park and domain boards, and rabbit boards.

The intricacy of the ecological problems set in motion is still far from being understood, but a series of dates concerning the weasel family illustrates the realization that the problems were not so simple as they seemed. The Rabbit Act of 1881 protected natural enemies of the rabbit; 1882, introduction of mustelids began; 1883–86, 4,822 ferrets, weasels and stoats were liberated by Government officials; 1888, the Government advertised for thirty thousand ferrets; 1893, ferret breeding in full swing. Then came the period of doubt: 1897, liberations ceased, since "no noticeable decrease in rabbits had been observed" and other harmful repercussions on the native fauna had become insistent; as a result, in 1936 all protection was removed from mustelids; and from 1939 a bonus of 2*s*. a tail was offered. This, along with the value of the skins, resulted in the destruction of well over two hundred thousand in the years 1944–48; yet the tables from which this number has been taken do not suggest that over all there is any serious falling-off in the mustelid population. Moreover, the author states that "no information is available as to whether the existing control measures have in the period under consideration, resulted in an improvement in the status of game and other birds, or alternatively whether there was a noticeable deterioration in rabbit control" (p. 81). Elsewhere, he remarks that rabbit control is "no nearer solution than it was seventy-five years ago when the rabbit was first considered a pest" (p. 127).

I mention these facts because the first purpose of this book, with its careful accumulation of facts concerning each of some twenty-nine introduced mammals—the past and present distribution, the reactions upon vegetational and faunal environments, the assessment of economic status, and methods of control—is to bring the record up to date. Its second and insistent purpose is to show that empirical attempts at control have never been successful, and that the method of gathering information from questionnaires cannot give standardized or strictly comparable answers. The only way of laying a firm foundation for the assessment of the 'value' of an established introduction, and so for judging the need for and the methods of control, is by field observations, carried out by trained scientific workers, associated with carefully designed and controlled ecological research, and all co-ordinated with the knowledge of the practical men of the farm, the forest and the game reserve.

This is a sound and interesting book, suggesting many ecological comparisons of similarity and difference with conditions in Britain. The author recognizes the difficulties of the problems involved, and rightly places his faith in long-term research in place of snap judgments and crude empiricism.

JAMES RITCHIE

THE UNIVERSITY OF BIRMINGHAM CYCLOTRON

THE Nuffield cyclotron in the Physics Department of the University of Birmingham is one of the three cyclotrons in Great Britain which were planned before the outbreak of war in 1939. The construction of a machine for accelerating deuterons to an energy of about 25 MeV. was proposed by M. L. Oliphant, who was appointed to the Poynting chair of physics in the University in 1937, and was responsible for the general planning and guidance of the whole work until 1950. The general design was based largely on that of the 60-in. cyclotron of the Radiation Laboratory of the University of California at Berkeley, and, like the Berkeley machine, the Birmingham cyclotron is of nearly the maximum economic size for fixed-frequency operation. The cost of the initial stages of the undertaking, including the provision of the building which now houses not only the cyclotron but also a large part of the research work of the Department, was met by a generous gift from Lord Nuffield. Financial support has also been given by the Nuffield Foundation and latterly by the Department of Scientific and Industrial Research.

Work on the machine, which started in 1938, was seriously interrupted by the War; but by 1944 the magnet had been assembled, with the view of electromagnetic separation of isotopes for the Atomic Energy Project. The transfer of Prof. Oliphant and his team to the United States ended this particular undertaking; but with the release of many members of the staff of the Department from war work towards the end of 1945 it became possible to continue construction of the cyclotron. An internal beam of 16 μamp. of 25-MeV. molecular hydrogen ions was obtained early in 1950, but sparkover in the deflector system made it difficult to extract beams of this energy, and distortion of the dees also gave trouble. The cyclotron was therefore adjusted to accelerate deuterons to an energy of 20 MeV., and an external beam was obtained in July 1950; since then the machine has operated steadily and well. It represents an important addition to British resources in nuclear physics, and this article has been written to give a brief general account of its main features. Certain specific aspects of the design have already been referred to in a recent review article on cyclic accelerators[1].

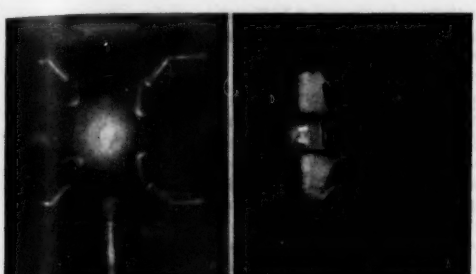
The cyclotron stands 15 ft. below ground-level in a pit at one end of the Nuffield Research Laboratory. The magnet pole tip diameter is 61½ in., and the effective air gap is 12 in. The flux density in the magnet gap under present operating conditions is 13,500 lines/cm.^{2}. The magnet yoke weighs 250 tons and the copper windings 40 tons. The magnetizing current is 230 amperes, and the coils dissipate a power of 40 kW. which is removed by an air-cooling system giving a flow of 21,000 cu. ft./min. The magnet can produce a field of 18,000 gauss with a dissipation of 200 kW., so that it is being operated well within its rating. The magnet current is held constant to one part in 10,000 by a stabilizer using a galvanometer and photocell to determine when the current deviates from a fixed standard of reference. The fall-off in magnetic field required for correct focusing properties is obtained by machined steps in the pole faces.

The operating frequency of the cyclotron is at present 10·24 Mc./s. and the peak voltage between the dees is 150 kV. The radio-frequency generator resembles that used in the 60-in. cyclotron at Berkeley; it is a single demountable grounded-grid oscillator using the dee system as a resonant circuit. The oscillator valve is a continuously evacuated tube with a water-cooled anode; the power input is 80 kW. The cathode and anode are coupled to respective dee-stems by a transmission line, coupling loop and terminating stub; the dee-stems are each the inner conductor of a coaxial line of 24 in. diameter which is shorted at one end and enters the main vacuum tank at the other. The radio-frequency system is driven into self-oscillation by a 1-kW. booster oscillator and power amplifier.

The cyclotron tank and dee lines are evacuated by two 14-in. oil diffusion pumps which maintain a pressure of about 2×10^{-5} mm. of mercury under normal operating conditions. When the cyclotron is accelerating deuterons, deuterium is admitted to the ion source at a rate of 35 ml./hr. The ion source is of the hooded arc type; filament life is 30–40 hr. and is ended by erosion of the tungsten under the arc column.

The circulating ion beam of the cyclotron may be partly extracted by electrostatic deflexion into a tangential exit-port, and thence through a 50-μ aluminium window into the air or on to an external target. Alternatively, a further vacuum system may be attached to the exit port, and part of the beam may be deflected by an auxiliary magnet into an observation chamber 16 ft. from the cyclotron. The

Fig. 1. Analysed beam of 20-MeV. deuterons from the University of Birmingham cyclotron. The angular spread is about 1/10° vertically and 2° horizontally, and the current density is 1 μamp. per cm.^{2}. The track of the beam shown is about 6 ft. long



(a) (b)

Fig. 2. (a) Tip of the ion source at the centre of the cyclotron when the machine is accelerating molecular hydrogen ions. (b) Same as (a), except that the machine is accelerating deuterons. The bright patch on the left-hand side is part of the dee-structure reflecting light from the forked end of the white-hot splitter plate

fringing field of the cyclotron and the field of the deflecting magnet, combined with slit systems in the path of the beam, can be used to provide an analysed beam with an energy spread of less than 1 per cent of its mean energy. The cyclotron is normally used for accelerating deuterons (D^+), molecular hydrogen ions (H_2^+) or alpha particles (He^{++}), for each of which resonance can be obtained at the frequency of 10·24 Mc./s. by relatively small variations of the magnetic field. Each molecular hydrogen ion of energy 20 MeV. is equivalent for transmutation purposes to two protons of 10 MeV. The beam currents normally obtainable are shown in the accompanying table.

Ion accelerated	Energy (MeV.)	Circulating beam (μamp.)	External beam		Analysed beam	
			Current (μamp.)	Energy spread (MeV.)	Current (μamp.)	Energy spread (MeV.)
D^+	20	250–350	40–70	1	4	0·15
H_2^+	20	50–100	10–20	1	1	0·15
He^{++}	40	10–25	1–7	2	0·1	0·3

The photograph (Fig. 1) shows an analysed beam of 20-MeV. deuterons with a density of 1 μamp./cm.^{2} and an angular spread of 1/10° vertically and 2° horizontally emerging into the observation chamber. When molecular hydrogen ions are accelerated, collisions between the ions and gas molecules in the tank during acceleration give rise to protons of half the incident energy, which return to the ion source and rapidly make it white hot. Fig. 2*a* is a photograph of the tip of the ion source taken through a window in the tank wall under these conditions; Fig. 2*b* is a similar photograph taken while the machine was accelerating deuterons.

Targets may be given high intensities of bombardment in the circulating beam, in vacuum in the exit port, or in air outside the exit port window, activities of many curies being obtainable with the shorter-lived products. In many cases the intensity of the bombardment is limited by the difficulties of target-cooling rather than by cyclotron performance. Thermocouples in the target-cooling system are convenient for monitoring the beam current in high-intensity bombardments; power inputs of several kilowatts to suitable targets have been used.

Experiments in progress with the cyclotron include studies of nuclear reactions induced by bombardment with helium-3, elastic and inelastic scattering of protons and deuterons by nuclei, angular and energy distributions of products of (dp), ($d\alpha$) and (dt) reactions, and the investigation of short-lived activities. For the latter work the cyclotron ion source may be pulsed by a circuit synchronized with an external time base. Such experiments must all be done on or near the machine; in addition, many long-lived radioisotopes can, of course, be made, and some have already been distributed to users through the Isotope Division of the Atomic Energy Research Establishment, Harwell. Isotopes required by members of the University of Birmingham can be processed chemically in the radiochemical laboratory of the Department. The cost of operating the cyclotron in power alone is at present in the neighbourhood of £2 per hour, and the machine normally runs for 40–60 hr. per week, with one day set aside for routine maintenance.

The background of neutron- and gamma-radiation produced by the cyclotron is very large near the target, a fast neutron flux of about 10^8 neutrons per cm.^{2} per sec. being obtained in the forward direction one metre from a beryllium target bombarded by 30 μamp. of 20-MeV. deuterons. The cyclotron is surrounded by water tanks and concrete blocks to a thickness of 40 in., and in occupied regions in the neighbourhood the radiation intensity does not exceed the maximum permissible level.

The completion and successful operation of the Nuffield Cyclotron was made possible only by the combined efforts of a large number of individuals. Nearly the whole machine was constructed by the workshop and scientific staff of the Physics Department, and the assembly of the major parts of the equipment was also the responsibility of members of the laboratory. By comparison with later cyclotrons some deficiencies in the engineering of the machine are apparent, but the general serviceability and performance since 1950 have been good. The Department has the satisfaction that the time and effort expended on construction have been rewarded not only by the success of the machine, but also by a detailed appreciation of its operating characteristics.

[1] Fremlin, J. H., and Gooden, J. S., "Cyclic Accelerators", Reports on Progress in Physics, **13**, 295 (1950).

UNDER-WATER TELEVISION AND MARINE BIOLOGY

By Dr. H. BARNES

Scottish Marine Biological Association, Millport

ALTHOUGH in recent years there have been some advances in technique, notably in the use of the echo-sounder and in the development of the Hardy continuous plankton recorder, the marine biologist still relies to a very large extent on old methods for obtaining his 'field' information on the ecology of marine animals. The standard equipment such as nets, grabs and trawls have certainly been improved by various modifications, and their method of working and the results obtained have been subjected to a more critical examination; but such equipment can only give limited information regarding both the detailed distribution and behaviour of the animals in their natural habitats. In this sense progress in marine biology has not kept pace with that in physical oceanography, where there has been considerable technical advance, particularly in respect

of methods which are required to obtain an approach to a synoptic picture.

In a number of laboratories, under-water photography has recently been considerably developed as a biological technique, and some valuable results have been obtained in this way. However, this method suffers from a number of rather severe limitations. If the camera is manually operated it is necessary to employ a qualified diver or specially trained personnel, and unless only very moderate depths are to be explored complete diving equipment is necessary: even so, unless resort is made to equipment such as the bathysphere, the depths that can be investigated in this way are still only moderate in comparison with those at which marine animals are known to live; further, the time available for any one series of observations is limited. On the other hand, if the camera is operated from a ship, the investigator has no knowledge of what he is looking at, so that much time and film is wasted, and further, unless a cinécamera is used, the pictures of living and moving objects taken in this way are often difficult to interpret.

The announcement by the Admiralty of the use of under-water television in its work clearly raises the possibility of its uses in marine work in general. In fact, an under-water television project for use in marine science had been under development for some time before this announcement was made. Preliminary inquiries were begun in 1948, and in the following year, as a result of the kind co-operation of Dr. E. Hindle in granting facilities at the Aquarium of the Zoological Society of London, it was possible to demonstrate with a large variety of marine animals the quality of picture (from the zoological point of view) which might be approached. The demonstration was arranged by the E.M.I. Research Laboratories, which from the very first inquiries had shown keen interest in this project.

As a result of this preliminary work the Council of the Scottish Marine Biological Association, under its president, Prof. C. M. Yonge, made application to H.M. Treasury for a grant from the Development Fund: the matter was referred to the Development Commission's Advisory Committee on Fisheries Research. A grant was recommended and a scientific group set up under the chairmanship of Prof. A. C. Hardy, with which group the development of the project was to be in close contact.

The equipment, which is now almost ready, is being made by the E.M.I. Research Laboratories, and the C.P.S. Emitron camera equipment is being employed. It is anticipated that in the use of under-water television in the marine biological sciences the 'picture quality' will be of paramount importance. Under the term 'picture quality' are included such factors as adequate definition, complete freedom from shading and fidelity of picture tone quality—all these factors resulting in a picture of photographic quality. In all these respects it would seem that the C.P.S. Emitron camera is as adequate as any of the systems so far developed.

In order to give facility for observation, remote control of iris, focusing and lens turret (giving wide range of lens angle) have been developed and are incorporated in the equipment. In the first instance the development and use of the equipment is to be carried out on board the research ship of the Association, the 75-ft. M.V. *Calanus*; the layout of the control, power and viewing units has therefore been specially designed for working in a small space. The boat has available 7 kW. of power, and a converter has been installed to provide alternating current for the equipment (2·5 kW.).

While the equipment has been under manufacture, opportunity has been taken of making some preliminary investigations using prototype equipment. This work has been done at Millport in the large concrete tank used for oyster investigations. In this tank, which is 60 ft. long, 30 ft. wide and 7 ft. deep, lighting, turbidity and equipment may be readily controlled, for the difficulties inherent in handling the gear on board ship are absent. The tests included examination of fish, bottom fauna and plankton under varying conditions of lighting and turbidity. (The latter was estimated by means of a modified Pettersson instrument, and the results are quoted as percentage transmission of the value in air.) A number of modifications in the equipment were tested, including some camera tubes specially designed for the project. The results have so far been very encouraging. For example, using a 2½-in. lens with a turbidity of 73 per cent, adult cod (about 18 in. in length) were readily distinguished by their ordinary 'zoological' features at 16 ft. In a turbidity of 63 per cent the 'twitching' of the antennules of moderate-sized crabs could be readily seen at 6 ft., the lens magnification available allowing more detail to be seen than would be possible by direct visual observation at this distance and under these conditions. The planktonic euphausid *Meganyctiphanes norvegica* was very clearly seen in the latter turbidity at 1 ft., the rapid motion of the fine appendages being quite visible. The accompanying photograph of this species is believed to be the first one of a plankton organism to be taken through under-water television. For the purpose of comparison it may be stated that the turbidity of the sea in this area was about 86 per cent during the course of these experiments.

There are, no doubt, many problems to be solved; some will relate particularly to specific uses of the

The euphausid *Meganyctiphanes norvegica* photographed by under-water television

new technique, while others will relate to the working of the equipment on board a small ship. Further, as with all other methods, under-water television will have its limitations, but the preliminary results support the view that it will be a valuable addition to the techniques available for marine biological work.

In the development of complicated and expensive equipment such as is required in this work, help is needed from many sources. I wish to acknowledge a deep debt of gratitude to all those who have given of their assistance and advice, in particular to Prof. A. C. Hardy and to Dr. J. D. McGee (of E.M.I.), who from the very beginning have encouraged the project; to the Development Commission for recommending, and H.M. Treasury for making, a generous grant; to the management of E.M.I., particularly to Mr. G. E. Condliffe, director of research, and to Mr. P. L. Johnson and his colleagues for all their work in the preliminary investigations.

ALCHEMY AND ART*

By Prof. JOHN READ, F.R.S.

AT the outset it must be emphasized that alchemy was more than a rudimentary form of experimental science. In its widest aspect it was a philosophical system. In their true significance, the efforts of the adepts to transmute metals were attempts to prove the truth of the broad philosophical system of alchemy by means of material experiments.

Alchemy endured for more than a millennium; but it has long been outmoded, and there is little realization at the present day of the extent to which alchemical conceptions and imagery permeated the thought and art of the Middle Ages[1].

Art played an important part in alchemy. In examining this part in some detail it is impracticable in this place to do more than select a few outstanding items from the prodigious array of alchemical literature.

First, there are many beautiful alchemical manuscripts, often adorned with drawings or paintings. For example, an illustration in a fifteenth-century manuscript version of Norton's "Ordinall of Alchemy", a work written in 1477, in rhymed English verse, shows the Bristol alchemist, Thomas Norton, seated before a balance[2]. This illustration was later engraved by Thomas Vaughan for Ashmole's "Theatrum Chemicum Britannicum" of 1652, which contained the first printed version of the "Ordinall". Vaughan modified the original drawing and provided it with a characteristic ornamental border[3]. Incidentally, the original rendering possibly contains the earliest representation of a balance enclosed in a case.

One of the most beautiful and artistic of all alchemical manuscripts is the copy of Trismosin's "Splendor Solis" in the British Museum. This Harley MS. 3469, dated 1582, is a striking example of an alchemical manuscript of the late medieval period. It consists of a German text of forty-eight leaves, illuminated in gold, with twenty-two coloured allegorical paintings of great beauty, representing alchemical ideas and processes.

The fifth of seven paintings of the Hermetic Vessel, or Philosopher's Egg, depicting successive operations of the Great Work, shows the stage at which the colours of the peacock's tail were supposed to appear in the Vessel. The brightness and freshness of the colours in the original are very remarkable[4].

With the arrival of printed books, engravings supplanted the earlier kinds of pictorial representation. Alchemical engravings began with the woodcut, from which, as in the outer world of art, there was a gradual movement, first to the copper plate and etching, and later to the stipple engraving and mezzotint.

Some of the earliest woodcuts of chemical interest are to be found in works dealing with severely practical applications of the incipient science, rather than with the nebulous and mystic aspects of alchemy. In 1474 appeared Puff's "Von Den Gebrannten Wassern", with its bold unhatched woodcuts in the stiff and angular Gothic style.

Another early work dealing with the same subject of distillation from the practical point of view was Brunschwick's "Destillierbuch", first published in 1500 at Strasbourg. Grüninger's cuts, in this and other books, often have a silvery appearance evoked by numerous parallel unhatched lines. Sometimes an illustration of a piece of apparatus includes also a glimpse of a medieval panorama. Occasionally the engraver achieves an outstanding design[5].

One of the earliest surviving representations of a medieval alchemist at work is a woodcut by Hans Weiditz, a leading illustrator of the Augsburg school, who was known as the Petrarcameister. This woodcut[6] was executed about 1520, and first appeared in the "Trostspiegel", a German translation of Petrarch, in 1532. In the melancholy air of the alchemist and his assistant we may perceive an element of caricature.

The feeling of these German woodcuts and books is very different from that of the Aldine publication "Pretiosa Margarita Novella", printed by Paolo Manuzio at Venice in 1546. The somewhat lifeless woodcuts[7] show little cross-hatching; but in their greyness they form a harmonious balance with the delicate italic type. This book, which was sold somewhat later to the printer Ziletti, is one of the few illustrated Aldine publications, and is much valued by collectors.

At about this time, in 1556, was published at Basle that great medieval work on mining and metallurgy, Agricola's "De Re Metallica". It is a handsome work in folio, profusely illustrated with woodcuts. These give an admirable idea of processes and machinery, although they lack the real artistic fire[8].

Most of these early alchemical engravings delineated apparatus and practical operations. It was early in the seventeenth century, when alchemy had already begun to wane, that some of the most interesting and artistic engravings were produced. This period coincided with the development of copper engraving.

Outstanding among these engravings are the beautiful creations at Frankfurt-on-Main of the two de Brys and their successors, Merian and Fitzer, who married two daughters of Johannes Theodorus, the younger de Bry; Fitzer, a Londoner, espoused the youngest daughter in 1625.

The most noteworthy of these alchemical engravings occur in various works of Count Michael Maier, and especially in "Atalanta Fugiens", published at Oppenheim in 1618.

Particularly noteworthy is de Bry's ornamental title-page[9] of the work, in which, incidentally, Maier

* Substance of a Friday Evening Discourse delivered on March 14 at the Royal Institution, London.

stresses the imagined strong connexion between alchemy and music.

A typical page from that very rare book shows the four elements as four brothers facing an assailant armed with a club. This bold engraving illustrates in a striking way the use of various systems of shading in the representation of different kinds of textures. The human figures are posed effectively against the distant background. Strong modelling and the skilful use of shadows lend an effect of solidity to a composition marked also by its brilliance. Here, too, as throughout the book, the engraving harmonizes with the handsome Roman and italic types[10].

Another interesting feature of these fine engravings, as may be well seen from a second example, is that they show an interesting blend of Gothic and Renaissance styles. This second captivating design[11] symbolizes the heating of the Hermetic Vessel, or Philosopher's Egg, the alchemist being shown in the guise of a strange, fanatical figure wielding a sword, symbolic of fire.

The paved court, the passage beyond, the doorway with its classical surround, might have been copied from Raphael; at the same time the skyline is broken by sharp-pitched Gothic roofs and dormer windows. So insistent is the perspective that the eye is drawn to the Egg and beyond it to the distant end of the passage; and the swordsman, for all his bulging muscles, seems dream-like and nebulous.

The engraving calls up a vision of a Surrealist painting of some empty courtyard with marble statue and cold, blue shadows. Indeed, Surrealists have much to learn from the disturbing and incongruous juxtapositions of alchemical art. Moreover, illustrations from the "Codex Germanicus", a fourteenth-century manuscript, and from other alchemical sources, such as "The Book of Lambspring" with its receding perspectives, suggest that modern art has stepped back a long way in order to leap forward[12].

So far, we have considered the alchemist making use of art. Let us now alter our point of view and consider the artist making use of alchemy. Here, to take a broad view, we recall that medieval art drew its inspiration largely from the tenets of Christianity, held in that age with so much fervour and devotion. Medieval art owed a great deal to the patronage of the Church. Also, with the coming of the Renaissance, it drew new life from the great flood of classical knowledge.

Now there was a close connexion between alchemical tenets and certain religious doctrines, including the Redemption and the Resurrection. Also the Philosopher's Stone was often regarded as a triune microcosm, in which the alchemical mystery was linked with the Christian mystery of the Trinity[13].

It was therefore natural that alchemical symbolism often found an expression in decorative architecture, in stone, and in coloured glass, as well as in engraving and painting. "For the thought written in stone," wrote Victor Hugo, "there existed at that period a privilege comparable to the present liberty of the press. It was the liberty of architecture."

This liberty was sometimes used for recording alchemical ideas. For example, some of the decorative sculpture of Notre-Dame, which was at one time a resort of Hermetic philosophers, carried an alchemical significance.

Moreover, Nicolas Flamel, also in Paris, blended the art of the architect and the sculptor with that of the painter, in the famous alchemical frescoes with which he adorned the Churchyard of the Innocents, early in the fifteenth century.

Similarly, in London, Canon Ripley's allusion in the fifteenth century to "Westminster Church, to which these Phylosophers do haunte", calls to mind Ashmole's reference to a stained-glass window in St. Margaret's Church, with a design symbolizing the processes of the Great Work, and his further mention of an alchemical painting which formerly adorned an arched wall in Westminster Abbey.

A brief indication of the influence of alchemy upon pictorial art in the Middle Ages is best obtained by reference to a single alchemical conception. For this purpose we may select the Saturnine mysticism which permeates the whole corpus of alchemy. This Saturnine mysticism has many phases, and is complicated further by an ambivalent characteristic which cannot be discussed here.

One of the engravings[14] in "Atalanta Fugiens" illustrates the mythological story of Saturn, or Kronos, who was given to swallowing his offspring until foiled by Rhea's device of substituting a stone wrapped in swaddling clothes in place of the infant Jupiter. Maier's comment runs: "There is a Stone on the topmost height of Helicon, which his father swallowed and spewed up instead of Jupiter . . . that Stone of Saturn is the Chymists' Stone".

The Saturnine mysticism is thus associated with infants, and with the so-called *ludus puerorum* motif, according to which the attainment of the Stone is represented as "child's play", or "woman's work", after the successful accomplishment of the first stages. This motif is associated in turn with rebirth or renewal of life, following upon the stage of the Great Work known as "putrefactio", or death. Metals, like seeds (according to the mistaken medieval view), were supposed to die and putrefy before they could be revivified, ennobled, or undergo multiplication. The symbol of Saturn, or the associated metal lead, was often darkened, like the sphere and black crow in certain alchemical illustrations. The contemplation of death (often represented by a skull) was closely bound up with the doctrine of melancholy, which is inseparable from the Saturnine mysticism.

Another outstanding element of this mysticism was measurement, including that of the passage of time. Wetness, or humidity, was a further element of the first importance.

As a specific example, Dürer's masterpiece of copper-engraving, the "Melencolia" of 1514, incorporates most of the Saturnine elements. Indeed, every detail in this astonishing composition[15] bears an alchemical significance, obvious at a glance to a connoisseur of alchemy, although this interpretation has been largely overlooked; for, as mentioned at the outset, alchemy has been outmoded for so long that there is now little realization of the extent to which its conceptions and imagery permeated medieval thought and art. The crucible, the seven-runged ladder, the rainbow, the sharp implements, are all familiar in alchemical symbolism. The Saturnine mysticism finds expression in the instruments of measurement—the compasses, balance, and hour-glass; in the watery background; in the infant seated on the grindstone; and in the face of the winged genius of Melencolia, which, like the Saturnine symbols of alchemy, is darkened.

The Saturnine mysticism may also be recognized repeatedly in paintings of other leading artists of Dürer's time, including particularly Cranach, Giorgione and Campagnola. Three of Cranach's com-

positions deal with Melencolia. One of them depicts two infant boys levering forward a sphere and a third with a hoop. The sphere and hoop correspond to the grindstone on which Dürer seated his infant. These symbols are all suggestive of change and regeneration, like that older symbol of ancient Egypt, the serpent biting its own tail, signifying eternity.

In another painting Cranach shows fifteen infant boys at play, of whom some are dancing and two are playing on the flute and drum. There are other examples in alchemy of the use of music as an antidote to melancholy.

A similar painting in "Splendor Solis" shows also a bath suggestive of humidity, and a black crow, representing "putrefactio". The woman shown in each of these paintings must be taken as an allusion to the alchemical motif of "woman's work"—the *opus mulierum*, associated so often and so closely with the *ludus puerorum*.

About a century later, Teniers gave a charming representation of the idea of the *ludus puerorum* in his painting of alchemical cupids busily engaged in a laboratory[16].

A study by Campagnola shows an ancient philosopher meditating in solitude, surrounded by the Saturnine adjuncts of compasses, scales, a skull and a dragon emerging from the water.

Finally, we come to that mysterious being, the alchemist himself. With his strange and fantastic background, he has provided an attractive subject for generations of artists and engravers[17].

[1] For more detailed accounts of alchemy, see the writer's article, "Alchemy and Alchemists", *Nature*, **168**, p. 759, November 3, 1951; also "The Alchemist in Life, Literature and Art" (London and Edinburgh, 1947), and "Humour and Humanism in Chemistry" (London, 1947).

[2] See Plate 34 in the writer's "Prelude to Chemistry" (London, 1936; 2nd edit., 1939; New York, 1937; now out of print).

[3] *ibid.*, compare plate 15.

[4] *ibid.*, frontispiece.

[5] See Figs. 8 and 9 in "Humour and Humanism in Chemistry", and Fig. 7 in "Prelude to Chemistry".

[6] See plate 8 in "The Alchemist in Life, Literature and Art".

[7] See Fig. 6 in "Prelude to Chemistry".

[8] *ibid.*, plate 9.

[9] *ibid.*, plate 44.

[10] *ibid.*, plate 48.

[11] See plate 6 in "The Alchemist in Life, Literature and Art".

[12] For this part of the Discourse the writer has drawn upon the article by his son, Mr. J. H. (Jan) Read, "Some Alchemical Engravings", in *The Burlington Magazine*, **85**, 239 (1944).

[13] See plate 19 in "Prelude to Chemistry".

[14] *ibid.*, plate 50.

[15] See plate 14 in "The Alchemist in Life, Literature and Art".

[16] *ibid.*, plate 22.

[17] Reproductions of representative engravings and paintings of alchemists and alchemical interiors, notably by artists of the Low Countries, were shown in the Discourse; most of these may be found in "The Alchemist in Life, Literature and Art".

OBITUARIES

Dr. H. D. Dakin, F.R.S.

HENRY DRYSDALE DAKIN was born in London on March 12, 1880, the son of a Leeds iron and steel merchant. After being at the Leeds Modern School and with Mr. Fairley, the City analyst of Leeds, Dakin became a student at the old Yorkshire College, now the University of Leeds, in 1898. After working in Prof. J. B. Cohen's laboratory he graduated in 1902 and later became M.Sc. and D.Sc. In 1902 Dakin was elected the 1851 Exhibitioner for that year, and, his interest having been aroused in what was then the new subject of biochemistry, he began work in this field at the Lister Institute in London, where he effected a synthesis of adrenalin while investigating the properties of substances allied to adrenalin; he also worked with Kossel at Heidelberg. In 1905 Dakin accepted an invitation to work in New York in the private laboratory of Dr. C. A. Herter, which had been established at the top of the latter's house in Madison Avenue. Herter died in 1910, and at the request of the widow—who became Mrs. Dakin in 1916—Dakin assumed charge of the laboratory; and afterwards at Scarborough-on-Hudson, where it was re-established when the Dakins moved there after the First World War. Here Dakin's researches, described by one of his collaborators as being of an "unhurried perfection and elegance", were continued in an atmosphere so congenial to Dakin's temperament.

Dakin's work on the intermediary metabolism of fatty acids, and the study of their β-oxidation *in vitro*, provided an explanation by which, it was suggested, fatty acids are metabolized by the animal, was outstanding in its quality and profoundly influenced biochemical thought at the time. Much of Dakin's work up to this time is reviewed in his "Oxidations and Reductions in the Animal Body", a famous treatise of which a second edition appeared in 1922. His work on the action of alkalis on proteins, and the examination of the amino-acids which these racemized proteins yielded on hydrolysis, revealed a difference in the chemical constitution of such closely allied substances as the albumins from the eggs of ducks and hens, and the globulins occurring in the serum of animals—differences which were confirmed by physiologists and immunologists. The examination of caseinogens and globulins from other animal species followed and, although Dakin's work on amino-acids is perhaps better known, this attempt to elucidate the structure of larger molecules is typical of Dakin's work and thought at a period when methods were few, and limited in their application.

Dakin's name is probably best known, especially to the present generation, by the solution which bears his name. On the outbreak of the First World War, Dakin came to Europe and ultimately became interested in the treatment of infected wounds at a French hospital for the wounded at Compiègne. Here Dakin devised and perfected the hypochlorite solution still known by his name, and still used. A little later he was overjoyed at being invited to go to the Dardanelles; by his exertions, the *Aquitania*, which had been converted to a hospital ship, was fitted with a tank adapted for the electrolysis of sea water, and thus unlimited supplies of Dakin's solution became immediately available. Chloramine T, and Cohen's participation in this great work, came later. Dakin's researches continued as long as his strength to pursue them remained, among his later endeavours being his experiments on the active principle of liver extract.

Dakin was elected a Fellow of the Royal Society in 1917 and was Davy medallist of the Society in 1941. In recognition of his work in France he was appointed to the Legion of Honour. He was an honorary graduate of Yale and Heidelberg, and an honour and recognition which gave him great personal satisfaction was the award of the honorary LL.D. by his old University, an award which enabled him to visit the scenes of his early triumphs and friendships. His marriage brought him great happi-

ness, and Mrs. Dakin's death last year, after a long illness which had made an unwonted strain on Dakin's small reserve of strength, proved too much for his frail constitution, and there has passed from our midst one whose attractive personality and charm will be greatly missed. He was a pioneer of biochemistry, and for half a century his work has profoundly affected thought and progress in this field. He worked on many subjects and brought adornment and distinction to them all.

Percival Hartley

We regret to announce the following deaths:

Prof. F. T. Brooks, C.B.E., F.R.S., emeritus professor of botany in the University of Cambridge, on March 11, aged sixty-nine.

Lord Lindsay of Birker, principal of the University College of North Staffordshire, and formerly master of Balliol College, Oxford, on March 18, aged seventy-two.

Prof. N. V. Sidgwick, C.B.E., F.R.S., formerly professor of, and reader in, chemistry in the University of Oxford, on March 15, aged seventy-eight.

NEWS and VIEWS

St. John's College, Cambridge: Mr. J. M. Wordie, C.B.E.

Mr. J. M. Wordie, who has been appointed Master of St. John's College, Cambridge, in succession to the late Mr. E. A. Benians, took the Natural Sciences Tripos in 1913, specializing in geology, in which he won the Harkness Scholarship. Events were to prevent his following the normal career of a geologist, for in 1914 he sailed with Sir Ernest Shackleton's *Endurance* expedition. Here he had time to begin his studies of sea-ice while the whole party lived for months on the floating pack-ice, after their ship had been crushed. Wordie was with the main party, living under an upturned boat for some weeks on a barren sub-Antarctic island, while his leader was making his memorable boat-journey to South Georgia for help. He returned to England just in time to see a little service in the First World War as an artillery officer. He then went back to Cambridge to take up what can best be described as an academic life with exciting interludes.

Becoming a Fellow of St. John's in 1921, and successively supervisor, tutor, senior tutor and president, he has been in close touch with undergraduates for thirty years. Almost at once he began that series of summer expeditions to the Arctic—six in all—by which he has exerted a lasting influence on polar exploration. Most of the young men in those parties under his leadership have gone farther with polar work and all have maintained an intense interest in it. Mr. Wordie's knowledge of polar history is nearly as comprehensive as his polar library. As an original member of the Colonial Office *Discovery* Committee, as chairman of the Committee of the Scott Polar Research Institute, and now as president of the Royal Geographical Society, he has been in constant touch with almost every aspect of scientific exploration. His wise and cautious counsel will, no doubt, continue in these fields.

Television in Scotland

A further step in the carrying out of the B.B.C.'s plan for a nation-wide service of television (see *Nature*, 167, 617; 1951) was accomplished on March 14, when the fourth station in the network was formally opened at Edinburgh by Mr. James Stuart, M.P., Secretary of State for Scotland. The new station is at Kirk o' Shotts, near Falkirk, on a site 900 ft. above sea-level about midway between Glasgow and Edinburgh. The 750-ft. mast, similar to those used at Birmingham and Holme Moss, brings the total height of the sound and vision aerials to more than 1,600 ft.; and this is an important factor in securing the greatest possible service area, particularly in hilly country such as that lying to the north of the new station. The sound and vision transmitters operate on frequencies of 53·25 and 56·75 Mc./s. respectively (wave-lengths 5·63 and 5·3 m.).

As at Holme Moss, the Scottish station is being equipped with high-power transmitters for the main service, with medium-power transmitters to be held in reserve against breakdowns. As there is likely to be some delay in the completion of the high-power installation, it was decided to inaugurate the service with the medium-power transmitters, which were built to B.B.C. specification by Marconi's Wireless Telegraph Co., Ltd.; they form a completely separate installation and are housed in the annexe building. These medium-power transmitters are expected to provide a satisfactory television service over a considerable area of central Scotland, including Edinburgh and Glasgow; but reception will naturally be more liable to interference, particularly in fringe areas, than it will be when the high-power transmitters come into service later in the year. It is estimated that the new station will then enable between three and four million people to use the service—more than half the population of Scotland: with the other stations already in operation, television will be available to about three-quarters of the population in Great Britain.

The vision programme is conveyed to Kirk o' Shotts over the General Post Office distribution network, which consists of the 1-in. tube co-axial cable system from London to Birmingham, the $\frac{3}{4}$-in. coaxial cable from Birmingham to Manchester, and a radio relay link between Manchester and Kirk o' Shotts. This is the longest television relay system in Europe; and the fact that viewers in the London area were able to witness the inauguration ceremony in Edinburgh, as re-radiated by the Alexandra Palace station, was a testimony to its efficient operation. At this ceremony, Lord Tedder, vice-chairman of the B.B.C., introduced Mr. Stuart in the presence of Mr. James Miller, Lord Provost of Edinburgh, and a distinguished gathering. More than one reference was made to the fact that the late Mr. J. L. Baird, the pioneer of British television, was born at Helensburgh, Dumbarton, about forty miles from the new station. In the area of the new station, reception of the opening ceremony and the evening's programmes was described as excellent.

British Coal Utilization Research Association: First Coal Science Lecture

In his presidential address to the British Coal Utilization Research Association last year, Sir Charles Ellis referred to the establishment by the Association of an annual Coal Science Lecture. It is now

announced that the first of these lectures will be given by Sir Alfred Egerton on May 7, following the annual general meeting of the Association; Sir Alfred will speak on "Methane and Coal". The British Coal Utilization Research Association holds a special position among the research associations of Great Britain in that its membership includes the nationalized fuel industries and the Transport Commission as well as private firms; the Coal Board in particular depends on the Association for the major part of its research on coal utilization. Nevertheless, the Council of the Association believes that practical aspects of research must rest upon fundamental knowledge of coal, and it has founded this annual Coal Science Lecture, which will be accompanied by a medal award, as a means of expressing its conviction of the importance of research of the highest order for the furtherance of our understanding of coal and its utilization. The first Coal Science Medal will be presented to Sir Alfred Egerton during the luncheon following the annual general meeting of the Association.

I. V. Sandström (1852–89)

Ivar Victor Sandström, who was born in Stockholm a century ago, on March 22, 1852, is remembered for a single contribution to science—his discovery of the parathyroid glands. He was educated at the University of Uppsala, where he taught histology for six years before taking his medical degree in 1887. In 1877, while dissecting a dog, he discovered the parathyroid glands; but it was only in 1880 that he published his findings (*Upsala Läkareförenings Förhandlingar*, 15, 441; 1880), after verifying them in other animals and in man. Though he regarded the parathyroids as embryonic portions of thyroid tissue and failed to appreciate their vital importance, his description was precise and accurate. Until the publication by the Johns Hopkins Press, Baltimore, in 1938, of an English translation of his original communication, scientific workers outside Sweden had only two German abstracts available to them. Unaware of Sandström's paper, Eugène Gley, of Paris, rediscovered the parathyroid glands in 1891 and pointed out their physiological significance. The active principle of the glands, parathormone, was isolated by J. B. Collip in 1925. It is interesting to note that Sandström credited both Robert Remak (1851) and Virchow (1864) with having seen and briefly described these bodies. Victim of a mental disorder, hereditary on his mother's side, which had caused a break in his studies, Sandström took his own life on June 2, 1889, at the early age of thirty-seven. His untimely death robbed the scientific world of a thoughtful and original investigator.

Microscopical Stains and Reagents

The foundation stone of new laboratories for Edward Gurr, Ltd., was laid on January 24 at Upper Richmond Road, East Sheen, London, S.W.14. These premises, when completed, will make that firm one of the largest businesses in the world specializing in the production of microscopical stains and reagents. This enterprise, developed since the end of the Second World War, now has a world-wide market for its products. Almost eighty per cent of the firm's production is exported. The price of these products is very high in relation to their bulk and to the shipping space they occupy, and they make a useful contribution to the British economy. Such considerations must have influenced the Town and Country Planning authorities in permitting the further extension of manufacturing premises within the London area. The policy of the managing director, Mr. Edward Gurr, is to meet customers' special requirements and, if necessary, to modify current products to the customers' own specifications. Mr. Gurr believes that a technical background is of more use in such an enterprise than a university training, and employs upwards of fifty technically trained workers. A useful service by the firm is the publication of staining schedules giving recipes for the use of the firm's products. Every histologist and microscopist has his favourite stains, and can choose from among four hundred and fifty stains, many of them recently developed, in the firm's catalogue, which ranges from water-testing chemicals to fluorescent dyes.

A New Development in Echo-Sounding

One of the more recent developments in the field of echo-sounding in water is the 'Fischlupe', made by the German firm of Electroacustic G.m.b.H., Kiel. This instrument is basically similar to other commercial sounders; but it differs from them in its method of presentation, being equipped with a cathode-ray tube instead of the more usual paper-recorder or flashing light. The depth range covered by the instrument is 300 fathoms (1,800 ft.), but any fish echoes falling within this range can be magnified to such an extent that the scale of the cathode-ray tube becomes 45 ft. instead of 300 fathoms, which, for those who wish to study the form of the echo, is a decided asset. The claim by the makers that single fish can be made visible, and that the species of fish can be identified, will need to be tested; but, whether these claims are justified or not, it will be interesting to watch the progress of this new sounder in connexion with the various commercial fisheries. The agents for this instrument in Great Britain are the Marconi International Marine Communications Co., Ltd.

X-Ray Analysis of Proteins

Sir Lawrence Bragg delivered the thirty-sixth (1952) Guthrie Lecture of the Physical Society on March 12, when he discussed "X-ray Analysis of Proteins". Sir Lawrence said that the attempt to discover the atomic arrangement in the protein molecule seems very ambitious. Ever since Bernal first showed that crystals of protein give X-ray diffraction pictures, it has been clear that a protein molecule of a given type is a structure with a definite individual form; the X-ray diffraction spots are very sharp and reproducible and extend to regions corresponding to interatomic distances. The molecules are, however, of great complexity. It has been a triumph of X-ray analysis to pass from simple substances like rock-salt to such molecules as strychnine or penicillin with about one hundred atoms. Attempts are now being made to analyse a molecule such as hæmoglobin, which contains fifteen thousand atoms. The reward, if an analysis were completed, would be great, because the determination of any one protein would undoubtedly cast a flood of light on the character of these bodies, which Nature has selected as the basis of living matter. Work on protein is proceeding in a number of centres. Investigations on hæmoglobin have been going on in Cambridge for the past twelve years under the direction of Dr. Max Perutz. More X-ray data for hæmoglobin are available than for any other protein. Though still a long way short of the goal, considerable advances have

been made recently, so great as to encourage us to hope that the problem is soluble and even that a solution lies not far ahead.

Iron and Steel Institute : Awards

The following awards have recently been made by the Iron and Steel Institute : *Bessemer Medal*, to H. H. Burton (English Steel Corporation, Ltd.), for his distinguished services to the steel industry and to metallurgy, with particular reference to the development of alloy steels and of heavy forgings ; *Sir Robert Hadfield Medal*, to Dr. L. Reeve (Appleby–Frodingham Steel Co.), in recognition of his contributions to the science and practice of ferrous metallurgy and, in particular, his researches on the weldability of low-alloy steels ; *Williams Prize*, jointly to J. A. Bond (Appleby–Frodingham Steel Co.) and T. Sanderson (Workington Iron and Steel Co.) for their paper on "Full-Scale Blast-Furnace Trials" (*J. Iron and Steel Inst.*, 168, 24 ; 1951).

International Seaweed Symposium at Edinburgh

An international seaweed symposium, sponsored by the Institute of Seaweed Research, Inveresk, Midlothian, will be held in Edinburgh during July 14–17. Sessions will be held in the Department of Zoology, University of Edinburgh, and will deal with the following major topics : phycology ; algal chemistry ; harvesting technology ; utilization in industry, medicine and agriculture ; world seaweed resources—survey and conservation. Papers will be about half an hour in duration and adequate time will be allowed for discussion. On July 13, the day before the opening, an excursion will be made to St. Andrews and the Gatty Marine Laboratory. During the symposium there will be excursions to the Institute of Seaweed Research and to Dunbar, where mechanical harvesting techniques will be demonstrated. Accommodation can be reserved at the University of Edinburgh students' hostels. Further information can be obtained at the Institute of Seaweed Research from Mr. T. W. Summers, secretary to the organizing committee for the symposium. During July 10–12, immediately prior to the symposium, the recently formed group of British phycologists is holding its annual summer meeting in Edinburgh. There will be excursions and prepared demonstrations of recent techniques in phycological research, with special emphasis on cytology, anatomy and culture methods. Those taking part in the international seaweed symposium are invited to take part also in this other meeting.

"Effect of Vitamin A-Deficiency on the Dark Adaptation of the Pigeon"

In the communication under this title published in *Nature*, March 8, p. 413, Mr. J. W. Waters inadvertently omitted the key to the graph. It should read : ○ - - - ○, normal pigeon ; □ - - - □, normal pigeon ; ●—●, 17 months deficient diet ; △ - - - △, 17 months deficient diet, followed by 1 month of 100 I.U. vit. A/gm. diet ; ▲—▲, 17 months deficient diet, followed by 4 months of 100 I.U. vit. A/gm. diet ; ■—■, 17 months deficient diet, followed by 4 months of 100 I.U. vit. A/gm. diet, followed by 5 months normal mixed diet.

Announcements

Mr. John Rogers, chairman of Imperial Chemical Industries, Ltd., has been elected a member of the Athenæum under the provisions of Rule 2 of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services.

Prof. René Garnier, professor of mathematics (analysis applied to geometry) in the Sorbonne, has been elected a member of the Geometry Section of the Paris Academy of Sciences in succession to the late Prof. E. Cartan.

Dr. A. Neuberger has been appointed chairman of the editorial board of the *Biochemical Journal* in succession to Dr. E. J. King, who is retiring. All communications regarding the *Biochemical Journal* should be addressed, after April 1, to Dr. Neuberger at the National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7.

Dr. B. K. Blount, director of scientific intelligence in the Ministry of Defence, has been appointed a deputy secretary in the Department of Scientific and Industrial Research. Dr. Blount's post is a scientific one, and he will be able to relieve the secretary of the Department, Sir Ben Lockspeiser, of some of the increasingly heavy burdens of that office.

The title of reader in applied mathematics in the University of London has been conferred on Dr. G. J. Whitrow in respect of the post held by him at the Imperial College of Science and Technology.

The Institute of Metals is offering two prizes of twenty guineas (10 guineas cash, and 10 guineas in books) for the best essays on each of the following subjects : non-ferrous foundry practice ; and metallography in industry. The competition is restricted to persons less than twenty-five years of age who are student members of the Institute or are associate members of local sections and eligible for student membership. Essays, which must not exceed 3,500 words in length, should be sent to the Secretary, Institute of Metals, 4 Grosvenor Gardens, London, S.W.1, not later than May 19.

A course of twelve lectures on the "Fundamentals of Applied Photography", arranged jointly by the Imperial College of Science and Technology, the Royal Photographic Society and the Institute of British Photographers, will be given, in the Physics Department of the Imperial College, South Kensington, London, S.W.7, on Tuesdays and Thursdays, at 4.30 p.m., commencing on April 29. The main purpose of the course is to provide instruction for those who wish to use photography in industry. The lectures will be accompanied by practical demonstrations, where appropriate, and will cover sensitometry, processing, spectral sensitivity, physical nature of the developed image, photographic photometry, latent-image theory, and applications to low-energy and high-energy quanta. The fee for the course is two guineas (free to students of the Imperial College). Further details can be obtained from the Registrar of the Imperial College.

The ninth annual private exhibition of British components, valves and test gear for the radio, television, electronic and telecommunications industries, which is known as the "British Radio Component Show, 1952", will be held at Grosvenor House, Park Lane, London, W.1, during April 7–9. Further information can be obtained from the organizers of the exhibition—the Radio and Electronic Component Manufacturers Federation, 22 Surrey Street, Strand, London, W.C.2.

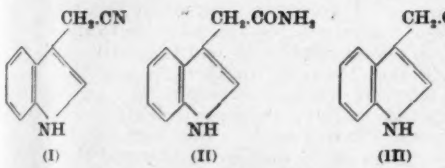
3-INDOLYLACETONITRILE: A NATURALLY OCCURRING PLANT GROWTH HORMONE

By Prof. E. R. H. JONES, F.R.S., Dr. H. B. HENBEST and Dr. G. F. SMITH
Chemistry Department
and Dr. JOYCE A. BENTLEY
Botany Department, University of Manchester

No plant growth hormones have as yet been isolated in pure form from actively growing plant material, although 3-indolylacetic acid (hetero-auxin) (III) and its ethyl ester have been obtained from seeds[1–4]. There have been several reports[5] of the existence in plant tissues of a neutral hormone, believed by some workers to be 3-indolylacetaldehyde. It has also been observed that plants of the Cruciferæ family contain a relatively large amount of growth hormone[6,7]. Linser[8] has reported recently that cabbage contains at least two growth hormones, which are easily separable by chromatographic methods.

It was established by one of us (J. A. B.) that ether extraction of brussels sprouts at about 8° gave material that exhibited high activity in the *Avena* straight-growth test. Separation of this extract into acidic and neutral fractions revealed the important fact that practically all of the activity resided in the latter, the activity of the acidic fraction being negligible. Extraction of cabbage leaves gave a similar result, and further work (with Dr. S. Dunstan) has shown that extracts from other members of the Cruciferæ family (radish, cauliflower, swede and turnip) also yield neutral fractions of high activity.

Biological assay by the *Avena* straight-growth method[9] was used for following the further purification of the non-acidic fraction from sprouts or cabbage. This was effected by chromatography on activated gypsum, followed by partition between aqueous methanol (90 per cent) and light petroleum, and finally by further careful chromatography. The small amounts of neutral material obtained in this way showed activities several times greater than those of 3-indolylacetic acid, and their ultra-violet absorption spectra indicated the presence of an indole compound.



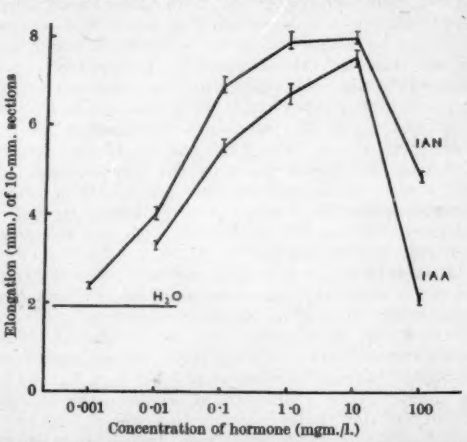
(I) (II) (III)

Through the courtesy of Drs. W. A. Sexton and T. P. Metcalfe, of Imperial Chemical Industries, Ltd. (Dyestuffs Division), a low-temperature (0–2°) extraction of 500 kgm. of cabbage with carbon tetrachloride was carried out and eventually yielded several neutral fractions, together weighing 915 mgm., all being considerably more active than 3-indolylacetic acid. Final purification was effected via a picrate, m.p. 124–130°, the regenerated hormone, now crystalline, having m.p. 34·5–36·0°. It was identified as 3-indolylacetonitrile (I) by micro-analysis, infra-red spectra, alkaline hydrolysis to 3-indolylacetic acid and reduction to tryptamine with lithium aluminium hydride. The synthetic nitrile (I), prepared from indole via gramine, has been described hitherto as an oil, but purification of such material via the picrate yielded the crystalline compound, m.p. 36–36·5°, which did not depress the melting point of the natural hormone on admixture. Furthermore, the ultra-violet and infra-red absorption characteristics, chemical properties and biological activities of the natural and synthetic compound were identical. The isolation of a nitrile is rather unexpected since very few substances of this class have hitherto been obtained from natural sources.

Avena straight-growth tests (results of a typical experiment are given in the accompanying graph) show that 3-indolylacetonitrile is more active in promoting cell-elongation than 3-indolylacetic acid over a range of concentrations from 0·001 mgm./l. to 1·0–10·0 mgm./l.; a 0·1 mgm./l. solution of the nitrile has approximately the same activity as a 1·0 mgm./l. solution of the acid. The inhibitory effect at concentrations above 1·0–10·0 mgm./l. is less with the nitrile than with the acid.

Some nitriles have previously been tested for biological activity, and it has been suggested that they owe their activity to hydrolysis to the corresponding acids[10,11]. The production of acid in solutions of 3-indolylacetonitrile in the presence of *Avena* coleoptiles has been studied using the techniques employed in a similar study on 3-indolylacetaldehyde[12]. The results show that in a 10 mgm./l. solution of the nitrile during twenty hours, acid is produced with an activity equivalent to a concentration of less than 0·1 mgm./l. of the acid. Thus, only a very small part of the activity of the nitrile in the straight-growth test can be ascribed to production of acid in the external solution.

Hitherto, the assay methods most used in auxin research have been the *Avena* curvature test and the



Relative activities of 3-indolylacetonitrile (IAN) and 3-indolylacetic acid (IAA) in the *Avena* straight-growth test. (Vertical lines denote 2 × standard error at each point)

RELATIVE ACTIVITIES OF 3-INDOLYLACETONITRILE (I) AND 3-INDOLYLACETIC ACID (III) IN VARIOUS ASPECTS OF GROWTH AND DEVELOPMENT

Growth phenomena	Concentrations of hormone (mgm./l.)	3-Indolyl-acetic acid	3-Indolyl-acetonitrile	Degree of activity	Reference to technique
1. Straight-growth of *Avena* sections	0·001 — 100	+	+	Nitrile > Acid	Bentley[9]
2. Curvature in standard *Avena* test	0·01 — 0·1	+	+	Nitrile ≏ Acid	Went[10], modified by Rawes and Hatcher[14]
	0·1 — 1·0	+	+	Nitrile < Acid	
3. Polar transport from apex to base in *Avena* coleoptile	0·05 — 0·5	+	+	Nitrile ≏ Acid	—
4. Transport from base to apex in *Avena* coleoptile	0·05 — 0·5	−	−	—	—
5. Curvature of split pea stems	0·1 — 20	+	−	Nitrile slightly active at higher concentrations	Went[15]
6. Inhibition of root-growth in cress	10^{-5} — 50	+	+	Nitrile < Acid	Modified from Moewus[16]
7. Inhibition of bud-growth in *Phaseolus multiflorus*	~ 20	+	−	—	—
8. Inhibition of petiole-abscission in apple*	~1·0 — 100	+	−	—	Barlow[17]
9. Initiation of cambial activity in *Salix* sp.	~ 20	+	+	Nitrile ≏ Acid	Modified from Gouwentak[18]
10. Root-initiation in *Phaseolus vulgaris*	~ 20	+	−	—	Mitchell and Stuart[19]
11. Parthenocarpic fruit development in tomato	~ 100	+	+	Nitrile ≏ Acid	Luckwill[20]

* Test kindly carried out by Mr. H. W. B. Barlow, East Malling Research Station, Kent.

pea test. Results using these tests (see accompanying table) clearly show, by comparison with the straight-growth method, that there are both qualitative and quantitative differences in response to the nitrile, and that neither would be satisfactory as an assay method. The nitrile is inactive in the pea test except at high concentrations. The possibility that the activity at high concentrations is due to production of acid from the nitrile is being investigated. In the *Avena* curvature test, the nitrile is approximately as active as the acid at concentrations of 0·1 mgm./l. and less, but its activity falls markedly below that of the acid at higher concentrations.

The contrast between the effects of the two substances in the straight-growth test and in the curvature test suggests that differences in permeation through cell membranes or in transport to the growing zone might be involved. Transport of the nitrile and of the acid in the coleoptile have been compared by measuring the growth response when agar blocks containing the substance are applied symmetrically to the upper or lower cut surfaces of 10-mm. coleoptile sections maintained in a moist atmosphere. These experiments show that there is marked polar transport of both substances from apex to base of the coleoptile (but not in the reverse direction); results of some of the experiments suggest that the nitrile may be transported at a greater rate than the acid. The lower activity of the nitrile at higher concentrations in the curvature test is therefore not due to lack of transport to the growing zone, nor is it likely to be due to greater inhibition of cell-elongation by the nitrile, since this does not occur in the straight-growth test. It is therefore probably due to greater lateral spread of the nitrile across the coleoptile, with a consequent reduction in curvature.

If the cells of the coleoptile are more permeable to the nitrile than to the acid (as suggested by transport experiments) and if the nitrile is converted into the acid by the plant material, then it is conceivable that higher concentrations of acid could be produced from the nitrile within the cells than could be achieved by the acid itself. This would explain the greater activity of the nitrile in promoting cell-elongation in the *Avena* straight-growth test, but it necessitates the assumption that enzymatic conversion of nitrile to acid is inhibited at higher concentrations.

A survey has been made of the activity of the nitrile over a range of other aspects of plant growth and development (see table). (Tests 7–11 were carried out with solutions of the natural product, prepared from concentrates, the exact hormone content of which was not known. The results can therefore only be regarded as preliminary, and the tests will be repeated with synthetic nitrile.) From results on the other aspects of growth considered in the table, it is seen that the nitrile is as active as the acid only in cambial initiation in *Salix* and parthenocarpic fruit development in tomato. However, in the latter tests there was a delay of about three weeks between application and swelling of the ovaries, whereas the ovaries treated with the acid began to develop immediately. This may indicate that the nitrile has to be converted into some second substance before any reaction can occur. In all the other tests the nitrile was either less active than the acid, or inactive at the concentrations tested. If the nitrile is active by reason of its conversion to a second substance, for example, 3-indolylacetic acid, then only *Salix* and *Avena*, of the species tested, can achieve this conversion efficiently.

Alternatively, the nitrile and the acid may both influence plant growth independently, that is, the results in the various tests may be due to the nitrile alone, to the production of acid from the nitrile, or to both these factors. In this connexion, it may be noted that 3-indolylacetamide (II), an obvious intermediate in the conversion, nitrile (I) ⇄ acid (III), is virtually inactive in the straight-growth test. It would clearly be of interest to examine the metabolism of the nitrile in the various plant tissues concerned.

It has been suggested by several workers that 3-indolylacetic acid in plant tissues arises from tryptophane (IV), and two biogenetic schemes, neither involving the nitrile, have been discussed[5]. Although there is as yet no definite proof even that the acid is derived from tryptophane *in vivo*, the accompanying formula scheme is put forward as depicting one possible route by which the nitrile could be formed from the amino-acid.

The identification of the neutral auxin of cabbage as 3-indolylacetonitrile (which can conveniently be abbreviated to IAN) will necessarily focus attention on the biological properties of nitriles in general.

$$\text{3-Indolyl—CH}_2\text{.CH(NH}_2\text{).CO}_2\text{H} \xrightarrow{-2H}$$
(IV)
$$\text{—CH}_2\text{.C(=NH).CO}_2\text{H} \xrightarrow{-CO_2}$$
$$\text{—CH}_2\text{.CH=NH} \xrightarrow{-2H} \text{(I)}$$

Preliminary observations have shown that 2 : 4-dichlorophenoxyacetonitrile (kindly supplied by Dr. W. A. Sexton) is more active than the corresponding acid in the straight-growth test.

It was mentioned earlier that the presence of a neutral hormone in a number of plant tissues has been reported by several workers, some of whom suggested that 3-indolylacetaldehyde is the active compound. In the light of the present work, and of the recent preparation and examination of the aldehyde in these laboratories[12], it is clearly desirable to re-examine the nature of the neutral hormone in these plants. In addition, Larsen[21] states that there is more neutral hormone in dark-grown than in light-grown plant material, and that this may be responsible for the higher rate of growth in the dark. These results suggest that the role of the nitrile in etiolation and phototropism warrants investigation.

Experiments with the nitrile along some of the lines indicated, including studies on its chemical properties, especially hydrolysis, are in progress. Full accounts of its isolation and of its biological properties will be separately submitted for publication in the *Journal of the Chemical Society* and in the *Journal of Experimental Botany* respectively.

The authors thank the Agricultural Research Council for grants which have made this work possible. They are indebted to Prof. E. Ashby and Prof. S. C. Harland for providing generous facilities in the Department of Botany in this University, and also to the following for valuable assistance during the investigation: Mr. S. Housley and Miss A. Bickle with the biological assays; Mr. Boardman, of James Woolley, Sons and Co., Ltd., and Dr. Gane, of the Low Temperature Research Station, Cambridge, in the early stages of the extraction; Dr. T. P. Metcalfe, whose help was responsible for the success of the large-scale extraction; and Dr. G. D. Meakins for interpretation of the infra-red data.

[1] Haagen-Smit, A. J., Leech, W. D., and Bergren, W. R., *Amer. J. Bot.*, **29**, 500 (1942).
[2] Berger, J., and Avery, G. S., jun., *Amer. J. Bot.*, **31**, 199 (1944).
[3] Haagen-Smit, A. J., Dandliker, W. B., Wittwer, S. H., and Murneek, A. E., *Amer. J. Bot.*, **33**, 118 (1946).
[4] Redemann, C. T., Wittwer, S. H., and Sell, H. M., *Arch. Biochem. and Biophys.*, **32**, 80 (1951).
[5] Summarized by Larsen, P., *Ann. Rev. Plant Physiol.*, **2**, 176 (1951).
[6] Linser, H., *Planta*, **31**, 32 (1940).
[7] Avery, jun., G. S., Berger, J., and White, R. O., *Amer. J. Bot.*, **32**, 188 (1945).
[8] Linser, H., *Planta*, **39**, 377 (1951).
[9] Bentley, J. A., *J. Exp. Bot.*, **1**, 201 (1950).
[10] Thimann, K. V., "Plant Growth Substances", Ch. 2, ed. F. Skoog, University of Wisconsin Press, Madison (1951).
[11] Veldstra, H., *Enzymologia*, **11**, 97 (1944).
[12] Brown, J. B., Henbest, H. B., and Jones, E. R. H., *Nature*, [**169**, 335 (1952)].
[13] Went, F. W., *Rec. Trav. Bot. Nérl.*, **25**, 1 (1928).
[14] Rawes, M. R., and Hatcher, E. S. J., Ann. Rep. E. Malling Research Station (1948).
[15] Went, F. W., *Proc. Kon. Akad. Wet. Amsterdam*, **37**, 547 (1934).
[16] Moewus, F., *Biol. Z.*, **68**, 118 (1949).
[17] Barlow, H. W. B., *J. Exp. Bot.*, **1**, 264 (1950).
[18] Gouwentak, C. A., *Ned. Akad. v. Wet.*, **44**, 654 (1941).
[19] Mitchell, J. W., and Stuart, N. W., *Bot. Gaz.*, **100**, 627 (1938).
[20] Luckwill, L. C., *J. Hort. Sci.*, **24**, 19 (1948).
[21] Larsen, P., *Dansk. Bot. Arkiv*, **11** (9), 1 (1944).

MULTIPLE NATURE OF THE ENZYMES OF *ASPERGILLUS ORYZÆ* AND OF HORSE-RADISH

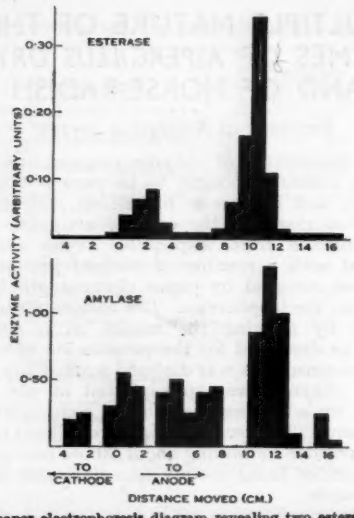
Enzymes of *Aspergillus oryzae*

THE complexity of enzyme preparations which were formerly thought to be pure is becoming apparent[1], and it may be of interest, therefore, to record that many of the enzyme activities in the culture filtrate from *Aspergillus oryzæ* are each associated with a number of distinct protein components as revealed by paper chromatography and filter paper electrophoresis. The culture filtrate was prepared by growing the mould on a synthetic medium as described for the preparation of crystals rich in protease[2]. It was dialysed against tap water, and the enzymes were precipitated at *p*H 7 and −20° C. by adjusting the ethanol concentration to 60 per cent. The precipitate was lyophilized to yield a bulky powder containing about 30 per cent protein, the remainder being mainly non-dialysable salts of organic acids.

The enzymes in the mixture were chromatographed on Whatman No. 54 paper by the descending method in an all-glass apparatus. Solvent mixtures of acetone and 0·01 *M* citrate–phosphate buffers were used in an atmosphere saturated with acetone and water. After drying, the papers were developed to reveal the distribution of the enzymes by spraying with suitable chromogenic substrates and incubating, in preference to employing the more tedious agar plate method of Reid[3]. With most of the substrates, spots corresponding to two or three separate components were observed.

That the separations observed were those of pre-existing components and not artefacts was demonstrated for the mould β-glucosidase. When run in *p*H 5·8 buffer-acetone (60 : 40 v/v) and developed with 0·05 per cent β(*p*-nitrophenyl) glucoside in 0·2 *M* phosphate buffer at *p*H 7·5, two components capable of hydrolysing this substrate appeared: component *A*, in the form of a well-defined round spot of R_F 0·7 after 20 cm. solvent travel, which could be removed from the enzyme mixture by precipitation at *p*H 8, −5° C. and a final ethanol concentration of 40 per cent; and component *B*, which appeared in the form of a long streak of R_F 0·2–0·55, and could be removed from the enzyme mixture by passage through an ion-exchange column. When similarly treated, almond emulsin also showed two mobile components and a third immobile component.

For filter paper electrophoresis the best separations were obtained with de-ionized material. An 'Amberlite' mono-bed ion exchange resin (a mixture of *IR*-120 and *IRA*-400) was effective in removing the non-protein constituents, but about 50 per cent of the protein was also retained on the column. Electrodialysis against distilled water gave a satisfactory product without significant loss of protein. The electrodialysed preparation was examined by filter paper electrophoresis by the method of Cremer and Tiselius[4], except that no cooling liquid was used. Whatman 3 *MM* or thick Munktell No. 20 filter papers gave the most satisfactory and reproducible separations. When subjected to a potential of 6 volts per cm. for 6 hr. in veronal buffer of ionic strength 0·025 and at *p*H 8·6, the protein spread over 20 cm. of the length of the paper. Separation of the protein mixture into four main components and at least



Filter paper electrophoresis diagram revealing two esterases and six amylases in enzyme preparation from *Aspergillus oryzæ*

three subsidiary components was demonstrated by staining with bromphenol blue. After electrophoresis, enzyme activities were determined on aqueous extracts of strips of the paper[5]. The diagram shows the distribution of amylase and esterase along the paper. Electro-osmotic movement of 1·5 cm. towards the cathode was demonstrated by observing the distance travelled by glucose under similar conditions. The multiple nature of the enzymes could also be demonstrated qualitatively by direct spraying of the paper with chromogenic substrates. The results of typical experiments are summarized in the accompanying table.

Method	No. of components in *A. oryzæ* enzyme preparation							
	Esterase	Amylase	β-Glucosidase	Sucrase	Cellulase	Protease	Catalase	Alkaline phosphatase
Paper chromatography	3	3	2	2	—	1	1	3
Paper electrophoresis	2	6	1	1	4	2	—	—

As the separations by these two methods depend on different physicochemical properties of the proteins, the components detected by each method for any particular enzyme preparation are not necessarily identical, and by varying experimental conditions, for example, the *p*H value and solvent employed, it may be possible to separate additional components.

A full account of this work will be published elsewhere.

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[1] Mills, G. T., and Smith, E. E. B., *Biochem. J.*, **49**, vi (1951). Martin, A. J. P., and Porter, R. R., *Biochem. J.*, **49**, 215 (1951). Hirs, C. H. W., Stein, W. H., and Moore, S., *J. Amer. Chem. Soc.*, **73**, 1893 (1951).
[2] Crewther, W. G., and Lennox, F. G., *Nature*, **165**, 680 (1950).
[3] Reid, W. W., *Nature*, **166**, 569 (1950).
[4] Cremer, H. D., and Tiselius, A., *Biochem. Z.*, **320**, 273 (1950).
[5] Wallenfels, K. and Pechmann, E. v., *Angew. Chem.*, **63**, 44 (1951).

Horse-Radish Peroxidase

In the course of the work on the paper chromatography of multi-component enzymes from *Aspergillus oryzæ*, it seemed desirable to test the reality of the separations observed by reference to an enzyme already known to be multiple. For this purpose horse-radish peroxidase, which Theorell[1] claimed to have split into two components, was selected. In view of the later partial withdrawal of his claims[3], which was overlooked, and the statement by Keilin and Hartree[2] that horse-radish peroxidase is a single enzyme, the following observations are presented.

500 gm. of minced horse-radish was disintegrated with three volumes of water in a Waring blendor, filtered through cloth and the filtrate (total volume about 1,500 ml.) saturated with ammonium sulphate, allowed to stand overnight, flocculated by centrifugation and the solid material filtered off. This material was suspended in a little water and dialysed for 24 hr. in a rotary dialyser against running tap-water. The resulting solution (about 50 ml.) was centrifuged to remove insoluble material and chromatographed on Whatman No. 54 paper using 0·01 *M* McIlvaine buffer (*p*H 6·0) – acetone (80 : 20 v/v) as solvent. After 20 cm. solvent travel the paper was dried and sprayed with a mixture of 100 ml. of saturated guaiacol solution and 5 ml. of 30 per cent hydrogen peroxide. The distribution of peroxidase from a single 10-μl. spot was shown by bright red areas on a white background as follows: (1) a relatively immobile spot of R_F about 0·02 (component *A*); (2) a long streak of R_F 0·2–0·5, densest at R_F 0·4 (component *B*); (3) an intense hourglass spot with its leading edge in the solvent front. This last spot could be resolved using a 70 : 30 v/v mixture as the developing solvent into two intense spots of R_F 0·7 (component *C*) and R_F 0·9 (component *D*). Dilution of the original peroxidase solution to about one-quarter strength was usually necessary to give sharp separations.

That the spots obtained by paper chromatography were not artefacts was demonstrated by separating the original mixture into two fractions by precipitation with an equal volume of saturated picric acid solution. The precipitate after centrifugation and washing free of picric acid with acetone was found to contain only components *A* and *B*, whereas components *C* and *D* were present in the supernatant. Neither fraction showed any sign of regenerating the lost components, and hence these are not artefacts of the chromatographic procedure. Components *A* and *B* thus correspond to the peroxidase I of Theorell's original claim, and *C* and *D* to his peroxidase II.

Further confirmation of the existence of more than one component in the original preparation was provided by filter paper electrophoresis at *p*H 5·7 in acetate buffer for five hours at 6 volts/cm. (kindly carried out by Mr. E. F. Woods), which showed two peroxidase components, one migrating 1·0 cm. towards the anode and one 1·6 cm. towards the cathode, as well as some immobile material.

The simplicity of the preparative method allows the minimum amount of 'paraperoxidase' formation,

and in any event it is doubtful if changes in the hæm portion of the molecule would have much effect on the properties leading to separation by filter paper chromatography. It therefore appears that peroxidase, as extracted from horse-radish roots commercially available in Melbourne, contains at least four components.

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[1] Theorell, H., *Ark. Kemi Min. Geol.*, **14B**, No. 20 (1940).
[2] Theorell, H., and Akerson, A., *Ark. Kemi Min. Geol.*, **16A**, No. 3 (1942). Theorell, H., *Advanc. Enzymol.*, **7**, 265 (1947).
[3] Kellin, D., and Hartree, E. F., *Biochem. J.*, **49**, 88 (1951).

THE TROÖDOS MASSIF, CYPRUS

By D. W. BISHOPP

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A PICTURE of the broader geological features of Cyprus has been provided by a comparatively few small scale maps and reports published at intervals by various authorities during the past century. The great igneous massif of Troödos in the south of the island has never been systematically mapped; it is about sixty miles long in its west-north-west direction and some twenty miles wide. Mount Chionistra (Troödos), 6,403 ft., is the highest and approximately the central point of the backbone of the range, the slopes of which are more or less adjusted to the angle of rest, say 35°. The earlier information indicates a main mass of 'diabase' containing two separate cores of plutonic rocks such as serpentine and gabbro, surrounded by a fringe of pillow lavas. The geological history, relationships, and boundaries of the Troödos rocks have thus remained very largely conjectural; though, as Cullis and Edge[1] pointed out, they are decidedly more complicated than is ordinarily supposed.

An account of the sedimentary rocks accompanying their map of 1946[1] on the scale of 4 miles to 1 in. was published by Henson, Browne and McGinty in 1949[2]. The much narrower Northern or Kyrenia Range, with peaks rising to a little more than 3,000 ft. above sea-level, consists mainly of folded and deformed Eocene–Cretaceous sediments, and is precipitous. Between this and the Troödos Range there is the Central Plain or Mesaoria, occupied by late sedimentary rocks. The oldest sediments of unequivocal age so far known have been referred to the Triassic, and occur in patches mainly to the south of the Troödos massif. They are known as 'Mamonia Complex' and include red and green shales, eruptive material, radiolarites, limestones, sandstones and siltstones.

In September 1950 a Geological Survey was inaugurated under the Cyprus Government in co-operation with the Directorate of Colonial Geological Surveys; its activities have primarily been directed to the systematic and detailed mapping of the Troödos massif, in which most of the economic minerals of the island are located: pyritic ores, asbestos and chromite. The area involved is about 1,200 square miles, and while this investigation is far from complete, certain features of general importance have become clear.

(1) The bulk of the Troödos massif is made up of the Folded Diabase Series: a complex of what appears to represent ancient basic volcanic flows and intrusive sheets, which occur in bands of variable thickness which commonly ranges between a few inches and a few feet. Epidiorites and other evidence of low-grade metamorphism are present. The outstanding feature of this formation is its structure: it contains several major anticlines and synclines with an axial trend a few degrees either side of north and south—frequently north-north-west—and with dips of the order of 60°–70° to east or west, rarely less than 45°. This is fairly uniform throughout the whole massif, but there are minor folds which show strong deformation, and the existence of isoclinal folding is not ruled out. This structure is generally responsible for the deep meridional valleys which flank the range. One appreciable low-angle thrust has so far been traced in the diabase for about three miles; it is accompanied by much shattering, and its sole, dipping northward, is at right-angles to the fold axes. This feature lies in the heart of the range west of Troödos, between Pedoulas Village and Kykko Monastery.

(2) The massif contains two plutons consisting mainly of serpentine and gabbro with minor bosses of pyroxenite. Chionistra, the highest part of the massif, lies within a polygonal core of serpentine of about 18 square miles in area. This is surrounded on north, west and south by a ring of gabbro one to three miles wide; to the eastward, however, the outcrop of this rock extends for some miles like the small end of a pear toward the second pluton, which is at a much lower altitude and is as yet unmapped. There is little doubt that there is continuity between these two plutons, albeit not yet revealed at surface. Present evidence suggests that the gabbro was emplaced later than the serpentine and not vice versa. The gabbro is intrusive into the folded diabase, and the latter shows a well-marked contact aureole in which epidote and quartz are developed. The diabase surrounds the gabbro and in places makes a roof over it; the boundary is sometimes sharp or else is sometimes characterized by a wide zone of roof-pendents and cognate xenoliths.

(3) The massif was eroded, and a land surface of high relief was formed.

(4) During and after the Triassic period, very extensive andesitic lavas, of which pillow-lava is the predominant form, were erupted through the periphery of the massif. There is a strong suspicion that the escarpment shown by the older rocks at the inner edge of the lavas has arisen through marginal faulting which gave passage to the volcanics. The lavas are generally unconformable to an eroded diabase surface; but they appear to graze both serpentine and gabbro at two points in the foothills south of Troödos.

(5) There was a phase of pyritic emplacements in the lavas and older rocks, and all three are intersected by later dykes. Erosion then produced another land surface of high relief, which sank to admit the seas and the unconformable deposition of the Lapithos (Cretaceous–Eocene) and later limestones in which there is no igneous activity, although they have undergone structural deformation from the Tauric orogeny which supervened. It follows that the pyritic ore-bodies, which are never far from the interface of folded diabase and newer lavas, were

emplaced before the second unconformity; so that Cullis's and Edge's hypothesis[3] that they were impounded by the sediments which sometimes overlie them can no longer be sustained.

(6) The intense Tauric folding which produced the Kyrenia (Northern) Range is approximately at right angles to the Troödos folding.

(7) There has been recent rejuvenation of valleys in the Troödos area, which have been scoured out, leaving a few high-level gravel terraces and making slit-trench bottoms with walls much steeper than the usual angle of rest.

(8) The apparent thickness of the Folded Diabase Series is demonstrably more than 5,000 ft. and may well exceed 10,000 ft.; but one does not know what deductions to make for dykes and sheets of material introduced *lit-par-lit*, and for the possibility of repetition by isoclinal folding. On the northern side of the range, pillow lavas have not yet been met at more than 1,200 ft. above sea-level, though this height appears to be exceeded on the southern flank where non-spilitic types such as agglomerates are more common. The thickness of the basal volcanics (andesites) which preceded the true pillow lavas may be of the order of 200 ft. in a limited area examined south of Karavostasi Port. Having regard to the seaward slope of the old surface over which the pillow lavas were emptied, it is difficult to assign to them, on the average, an excessively great thickness; possibly 2,000 ft. would be of the right order of magnitude on the northern side of the range, at their present stage of denudation.

(9) Bailey and McCallien[4] have laid some stress on the occurrence of the 'Steinmann Trinity'—radiolarite, pillow lava, and serpentine—in Turkey; but while these types are well represented in Cyprus, it appears that (*a*) they have been shielded from the extreme structural disturbances described in Turkey; (*b*) the Cyprus radiolarites are assigned to the Triassic; and (*c*) the serpentine of Troödos is of batholithic form and size and is probably older. This contrasts with conditions described in Turkey.

(10) The age of the Cyprus pillow lavas is admittedly pre-Maestrichtian. The Mamonia formation as described by Henson[2] contains, *inter alia*, red beds, tuffs and other volcanic material, and a Triassic fauna, so that its age is not in doubt. The Geological Survey has found similar red beds at points on the south-eastern and eastern margins of the massif, apparently interstratified with pillow lavas and agglomerates, and must conclude that at least a major part of the lavas is Triassic in age. In fact, the Triassic sedimentation was interrupted by this great volcanic phase; it produced a land surface which was afterwards denuded, and sedimentation was not resumed until it had sunk beneath the engulfing Upper Senonian sea. This land surface under the Lapithos limestones was still somewhat rugged, as the mapping shows. The vulcanism was of no mean order; the old crystalline core must have had a fiery perimeter more than 150 miles long, and we do not know how far the extrusive activity stretched away from it.

(11) Comparisons of Cyprus with the Turkish and Syrian mainlands must be made with reserve at this stage. It is evident that Cyprus is the meeting-place of two major tectonic systems: that of Troödos appears to be an ancient orogeny aligned with the African Rift Valley structures the trend of which is dominantly north and south. The Troödos massif acted as a resistant foreland to the much later Tauric pressure which produced the Kyrenia Range and probably the east to west thrust-traces and shattering in the Folded Diabase Series. The latter, as yet undatable but pre-Triassic, seems to be by far the oldest rock present. The history of the vertical movements of the island remains to be studied.

A report of anything resembling the Folded Diabase Series in the Eastern Mediterranean area would be of extreme interest. The petrology of this great mass of rocks remains to be studied in detail. It is not impossible that careful work may disclose material of sedimentary origin in the formation, but none has yet appeared.

No important occurrence of acid eruptives is known to exist in Cyprus, though a few quartz-bearing dykes have been noticed, and there are some very restricted occurrences of pitchstone and tachylite.

The great positive gravity anomaly due to the Troödos massif has long been known and adduced as evidence of the deep-seated character of its basic rocks. The latter would now be inferred regardless of geophysical evidence. The concept of Kober and others that, in the eastern Mediterranean, "Eurasia and Indo-Africa are sharply and uncompromisingly thrust against one another" is beautifully demonstrated in Cyprus, where the last wave of the Tauric pressure expended itself in vain against one of the most rigid rock-structures known—pre-folded and compressed epidiorite—and left the Kyrenia Range as its monument. The sediments south of the Troödos massif are, as one would expect, but little affected behind such a shield.

The present main objective of the Geological Survey is to produce a detailed map during the next few years, with special reference to the Troödos complex and its associated mineral deposits.

[Dec. 19.

[1] Geological Map of Cyprus, 4 miles to 1 in., 1946. R. V. Browne and J. McGinty, 42nd Geological Section, S.A.E.C., G.H.Q., M.E.F.
[2] Henson, F. R. S., Browne, R. V., and McGinty, J., *Q. J. Geol. Soc.*, **105**, 1 (1949).
[3] Cullis, C. G., and Broughton Edge, A., Report on the Cupriferous Deposits of Cyprus (London: Crown Agents, 1927).
[4] Bailey, Sir Edward, and McCallien, W. J., *Nature*, **166**, 938 (1950).

RADIO EMISSION FROM THE ANDROMEDA NEBULA

A PAPER by R. Hanbury Brown and C. Hazard on "Radio Emission from the Andromeda Nebula" has recently been published (*Mon. Not. Roy. Astro. Soc.*, 111, No. 4; 1951), and gives a very full account of the measurements of the radio-frequency radiation from the Great Nebula in Andromeda, using a wave-length of 1·89 m. Reber's attempt to detect such radiation by using a paraboloid of aperture 30 ft. on a wave-length of 1·87 m. was unsuccessful; but during the past few years a larger paraboloid of aperture 218 ft. and focal length 126 ft. has been installed at the Jodrell Bank Experimental Station of the University of Manchester, and the results, described in the paper, have been very satisfactory.

An account of the apparatus, with a block diagram, and also a polar diagram of the 218-ft. paraboloid, are given, followed by a description of the method of observation. The beam was fixed at a number of different elevations corresponding to the region around *M*31, so that it swept out a strip of sky 2° wide in declination and 24 hr. in right ascension, the

intensity of the radio flux received being recorded continuously for each elevation of the beam for about 100–200 hr. Of ninety records obtained, twenty were spoiled by the effects of rain during August and September 1950, and fifty of the remaining records showed the existence of a localized source of radio frequency at right ascension 00h. 40m.

The results afford conclusive evidence that the observed source lies close to the centre of *M*31, the right ascension being that given above and the declination N. 41°, Epoch 1950, and the apparent dimensions of the source are consistent with a source of radio frequency comparable with the main body of *M*31. It is most improbable that the finite width of the source is due to a coincidence of two point sources. A comparison of the measured intensity of the emission with that to be expected if *M*31 is similar to the galaxy is made on the assumption that the mass of *M*31 lies between 3×10^{10} and 10^{11} solar masses compared with 10^{11}–2×10^{11} for the galaxy, and on such assumption the intensity of the radio frequency from *M*31 would be expected to lie between 10^{-24} and 7×10^{-24} W. m.$^{-2}$ (c./s.)$^{-1}$, which include the observed values. The agreement suggests that *M*31 possesses similar characteristics to the galaxy as far as radio-frequency emission is concerned.

THE *ATLANTIDE* EXPEDITION*

IN June 1945 the Danish sculptor, Mr. Viggo Jarl, wrote to the University of Copenhagen to place his three-masted auxiliary motor-yacht *Atlantide* at the disposal of the University for a scientific expedition lasting up to ten months. Mr. Jarl not only undertook to finance the running of the ship but also allocated a sum of 10,000 kr. towards the scientific equipment.

Following this generous offer, plans were drawn up for an expedition off the coasts of tropical West Africa under the leadership of Dr. A. F. Bruun, of the Zoological Museum, University of Copenhagen, who was to have as colleagues two young zoologists, Mr. Jørgen Knudsen and Mr. Torben Wolff. Furthermore, when Prof. A. V. Hill, then secretary of the Royal Society, was on a visit to Copenhagen in June 1945, the plans for the expedition were widened. Prof. R. Spärck, head of the Zoology Department, proposed to Prof. Hill that the British Museum (Natural History) should be invited to collaborate in the work of the expedition. As a result, Dr. F. C. Fraser joined Mr. Jarl and the Danish scientists as the representative of the Museum.

The *Atlantide* sailed from Copenhagen on October 3, 1945, and returned on June 17, 1946. During her time at sea, 170 stations were worked, mainly between the Canary and Cape Verde islands, off French Guinea, Sierra Leone, Liberia, the Ivory and Gold Coasts, Nigeria, French Equatorial Africa, the Belgian Congo, Angola, Gambia and Senegal. The gear used for collecting the benthic organisms included otter and Agassiz trawls and various dredges, while Van Veen and Petersen grabs were used for bottom samples. Hauls for plankton and neckton were made with one-metre and two-metre stramin nets and a Nansen standard plankton net. In addition, hydrographic observations were made off the Gold Coast and Nigeria.

* *Atlantide* Reports: Scientific Results of the Danish Expedition to the Coasts of Tropical West Africa, 1945–1946. Report No. 1. Pp. 247+16 plates. 35 kr. Report No. 2. Pp. 303+2 plates. 40 kr. (Copenhagen: Danish Science Press, Ltd., 1950–1951.)

It is at once evident from Dr. Bruun's introductory report that the *Atlantide* Expedition was efficiently organized. At least three hundred species of fishes were taken, which is well over half the number known off the African coasts from Gibraltar to Cape Town. When this collection of fishes has been reported on, it must not only add to knowledge of the distribution and biology of the West African fauna but should also be of value to fisheries biologists at work in this area.

During the Expedition, attempts were made to harpoon the very elusive Delphinidæ, and eventually one was taken. This proved to be a male of the little-known species *Stenella frontalis* (Cuvier) and it is described by F. C. Fraser in *Atlantide* Report No. 1. The close comparative study of this dolphin in relation to other members of the genus has shown very clearly that the systematics will not be satisfactorily appreciated until a much larger series of individuals is at hand, together with observations on sex and the external and internal anatomy.

The anatomy of the urinogenital tract in this dolphin is described by L. Harrison Matthews. While the relationships of these organs in the Odontoceti show a general degree of conformity, Matthews clearly traces the resemblances of the male urinogenital tract of *Stenella* to that of other dolphins. Although this might have been expected, the paper shows that there are most interesting problems in the comparative anatomy of the urinogenital tract of the Cetacea awaiting further study.

A paper by Jørgen Knudsen on the egg capsules and development of the prosobranch molluscs has the freshness of approach which we have come to expect from the Danish biologists working on the reproductive larval ecology of invertebrates. Of the thirty-two species examined, twenty-two were found to have a non-pelagic development, whereas the remainder had a pelagic phase. This high proportion of species without pelagic larvæ is more like that found in colder waters than in the tropics, where species with pelagic larvæ are usually predominant. Knudsen suggests that this may be correlated with two environmental factors: first, the system of currents which would tend to carry planktonic larvæ away from settling areas, and secondly, the poor supply of planktonic food occasioned by the low nutrient-salt content of the Guinea Current.

Finally, in *Atlantide* Report No. 1, there are papers by Torben Wolff on the bird collection, by Bengt Hubendick on geographical variation in *Siphonaria pectinata* (L.), and by F. Jensenius Madsen on the Asteroidea. From a statistical study of shell characters, Hubendick finds a cline in the number of radii in the sculpture and in the pattern of the shell, and points out that this appears to be the first account of such variation in marine invertebrates. Madsen's well-illustrated systematic account of the starfishes contains descriptions of two new species of *Astropecten* and one new species of *Luidia*.

In *Atlantide* Report No. 2, the Echinoidea are reported on by Th. Mortensen, who describes a new species of *Brissopsis* nearly allied to the West Indian *B. elongata*, a further indication of the close relationship between the African and West Indian echinoids. The greater part of the report is taken up with papers by L. B. Holthuis on the caridean Crustacea and by D. M. Reid on the gammarid and caprellid Amphipoda.

The large collection of Caridea contains more than half the number of known species from tropical West African waters, many being represented by a good

size of individuals. Fifteen new species are described, and there are thirty-one new records. From this work Holthuis concludes that present knowledge of the distribution of most Caridea ". . . does not allow any definite conclusions to be drawn from the available data, other than stating the close relationship with the European and East American faunas and the much less clear affinity to the Indo-West Pacific Caridea".

Quite similarly, Reid finds that the extensive collection of amphipods comprises a great many species originally described from the European seas and the Mediterranean. In fact, comparatively few southern forms were taken, suggesting a dominant influence of the prevailing south-going current system. Twenty-four new species have been proposed and the collection contains forty-eight species not previously known from tropical West African waters. There is also a section on the problem of intersexes in the Gammaridea, and an appendix giving a list of the West African Gammaridea and their distribution which will be welcomed by specialists in this difficult group.

In conclusion, it should be recorded that the imaginative and generous interest shown by Mr. Jarl not only made possible a resumption of oceanographical work immediately after the War, but was also a great stimulus to Danish marine biologists after several years of isolation. The results so far published amply bear out the latter, and it is to be hoped that further *Atlantide* Reports will soon be ready. The publication of this well-produced series is being made possible by grants from Mr. Jarl and the British Museum (Natural History).

N. B. Marshall

FUNDAMENTAL EDUCATION

SINCE its foundation, Unesco has considered the problems arising out of illiteracy to be its major challenge and has developed programmes of "fundamental education" to help the 1,200,000,000 men and women in the world who can neither read nor write.

The main purpose of fundamental education is to help people understand their immediate problems and to give them the skills to solve them through their own efforts. It is an emergency solution designed to help masses of illiterate adults and children in countries the educational facilities of which have been inadequate.

Until 1950, Unesco's fundamental education work, because of a limited budget, was experimental. The experiments, however, repeatedly produced the same conclusions, no matter where they were conducted. Fundamental education cannot hope to achieve tangible results without men and materials, that is, without qualified workers and effective educational materials specifically designed for its task.

Neither, at present, is available. The demand for primers in Creole or agricultural manuals in Sesuto is not great enough to attract private capital to the long job of research required to produce them. Teacher-training schools ordinarily do not require their graduates to be able to teach reading in one class and contour farming in the next.

If each individual country were to attempt this job, the overall cost would be enormous, and an inevitable waste of money and man-power would result. The experiments showed that a pooling of resources at regional levels is needed.

Unesco has now put forward a plan to aid its member States by helping to train fundamental education workers and by developing samples of the teaching materials they need. This plan is intended to operate as a twelve-year programme in which a world network of six production and training centres will be established in five regions, namely, Latin America, Equatorial Africa, the Middle East, India and the Far East (where two centres will be set up). The plan was approved by the unanimous vote of the sixty-four member States of Unesco at the sixth session of the Unesco General Conference, which met in Paris during June–July 1951.

The goal of this programme is to train nine five thousand fundamental education specialists. These graduates, in turn, will staff similar training centres organized on national and local lines. It is these latter centres which will train the teachers who will work in the field.

Under Unesco's plan, each centre will be equipped to handle yearly two classes of a hundred students each. These students will be selected by their Governments and sent to the centre in their region not as individuals but as teams. A typical team studying at a centre might include an adult educator, a sanitary engineer, a nurse, a rural school teacher and an agricultural expert.

Some of the students at the centre will have been already trained in their own specialities under the guidance of three other United Nations agencies — the Food and Agriculture Organization, the International Labour Organization and the World Health Organization. They will come to the Unesco centres to learn how to put their technical knowledge to work in underdeveloped regions through fundamental education techniques.

The course of study planned for these students will cover twenty-one months. At first, there will be an intensive nine-month training period and then, after a one-month vacation, two months of "on-the-job training" at institutions conducting fundamental education work. The course will conclude with five months of practical field-work as teams in the vicinity of the centres, one month of vacation and a three-month refresher course at the centre.

A typical centre in operation will be organized to perform a four-fold task; namely, research, production of educational materials, teacher training, and aid to fundamental education activities in its region.

These functions will be carried out by three departments. The first, in charge of research, will determine the specific needs of the region in which the centre operates and the methods required to meet them. The second, or production department, will be responsible for developing sample text-books, films, film-strips, wall-charts and other materials needed in fundamental education. One of the five centres will be equipped with a complete production crew to turn out films and other visual materials. Another will be similarly staffed for radio work, with an experimental recording studio included in its equipment.

The teaching faculty of the centre will comprise the third or training department. Staff will be made up of instructors in sanitation, hygiene, agriculture, handicraft industries, home economics and literacy training, as well as general fundamental education specialists.

All three departments will contribute to the centre's fourth function of aiding fundamental education activities in its region. This aid will be carried out through missions by single experts or teams, the organization of conferences and study seminars and the exchange of information and documents—an important factor in this field where educators often work completely cut off from normal sources of information.

Since the purpose of these new regional centres is to train teachers and produce materials suitable for the particular requirements of each region, the operation has been decentralized to the greatest possible extent. In Paris, a co-ordinating body at Unesco House will supervise the activities of these centres. This body will also provide advanced training for students who show exceptional promise at regional centres.

The total cost of the programme, spread over twelve years, would be 20,000,000 dollars. A substantial part of the funds needed must be obtained from sources other than the normal budget of Unesco. It is believed that this can be achieved. This money cannot all come from the regions in which the centres will open, for they are areas in which little more can be done, for a long time, than to provide their populations with a hard-won living. Yet, obviously, it is in the interests of the entire world that its less-favoured regions should not be abandoned to illiteracy and disease, to poverty and recurrent famine and, worst of all, to despair.

In proposing its world plan, Unesco has more than a mere blueprint to offer. The first 'working model' of a regional centre is now in operation in Mexico, beginning the task of meeting the fundamental education needs of Latin America.

A full account of its working is set out in a recent Unesco pamphlet*. Although in its early days, the inspiration of Patzcuaro may well prove to be the beginning of a chain reaction culminating in the removal of one of the world's four great fears, the fear of ignorance.

* "Learn and Live." (Paris: Unesco, 19 Avenue Kléber, Paris; H.M.S.O., London.)

THE RADIO RESEARCH BOARD

REPORT FOR 1950

THE report of the Radio Research Board for the year 1950, together with the report of the director of radio research, Dr. R. L. Smith-Rose, has recently been published*. Four-fifths of the space is taken up by Dr. Smith-Rose's record of the year's activities, the nature of which may be gauged from the headings into which it is divided: propagation of radio waves along the ground; radio-wave propagation through the troposphere; the ionosphere and its characteristics; attenuation of radio waves in the ionosphere; forecasting of high-frequency radio propagation conditions; the ionosphere and low-frequency wave propagation; deviation of high-frequency radio waves transmitted by way of the ionosphere; research on materials of special interest for radio applications; investigation of fluctuation noise in valves and circuit elements; atmospheric noise; and measuring technique at very high radio frequencies.

* Report of the Radio Research Board, with the Report of the Director of Radio Research, for the Year 1950. Pp. 51. (London: H.M.S.O., 1951.) 1s. 9d. net.

This range of activities is so wide that it is difficult, and possibly invidious, to pick out particular topics for detailed comment. Perhaps the work of the Board as a whole can best be outlined by the following description, which is partly abstracted from the chairman's report. In the field of ionospheric research, in addition to the recordings made at the headquarters station at Slough, observations were collected from stations at Fraserburgh, the Falkland Islands and Singapore, and arrangements were being made to utilize recordings from Ibadan and Khartoum. Routine measurements were made of the height of reflexion as a function of frequency and of absorption occurring at vertical incidence; certain observations at oblique incidence were also made. All this information was used for the preparation of ionospheric forecasts. Further to this, the properties of the ionosphere at low frequencies have been examined, using signals from commercial transmitters at comparatively short distances.

Radio noise is of two kinds—atmospheric and that which is spontaneously generated in the circuit elements of the receiver itself; both phenomena have been actively investigated, and the first, because it involves the plotting of lightning flashes, has been of direct application to meteorology. Ground-wave propagation at low frequencies is of importance since it is the basis of several navigational aids, and equipment was being devised for the measurement of phase velocity. In the propagation of very short waves, recordings of radio field-strength under various conditions (particularly the distribution of the refractive index of the atmosphere), as they are affected by meteorological events, have been correlated statistically with the corresponding meteorological data. A radio-meteorological investigation, commonly known as the 'Canterbury Project', has been undertaken in co-operation with the New Zealand Department of Scientific and Industrial Research: it involves the measurement of transmissions of wave-lengths 3, 10, 60 and 300 cm. along a low-level duct about 100 m. high and up to 160 km. long which is made by the dry and warm (Föhn) wind blowing down from the southern Alps across the Canterbury Plains and out over the sea. Several results have been published and further analysis of the phenomenon was being continued.

Low-loss low-permittivity dielectrics, magnetic materials and semi-conductors have been investigated. In particular, the production of germanium free from arsenic has been studied in collaboration with the Chemical Research Laboratory, Teddington; the ultimate objective of the research is to provide information which will lead to the production of refined material suitable for making improved germanium diodes and triodes. In the work on very high frequencies (up to 3,000 Mc./s.) attention has been concentrated on the measurement of power, field-strength, impedance and dielectric properties and also on the development of centimetre-wave generators and the measurement of pulse parameters.

Finally, the abstracting service has been maintained during the year. This takes the form of abstracts and references prepared and edited by the radio research staff, some four thousand papers being noted annually. The work is published in the *Wireless Engineer* in Great Britain, and in the United States in the *Proceedings of the Institute of Radio Engineers* of America. This service is undoubtedly of great value to the radio profession all over the world.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Spontaneous Fission Rates

Measurements of the spontaneous fission rates of nearly twenty nuclides have recently been published. Most of these are given in a paper by Segrè[1], in which he describes the work carried out at Los Alamos during the War, and also sums up the results of other experiments. Measurements on curium-242 have been published by Hanna *et al.*[2].

The purpose of this communication is to point out the consequences of plotting the spontaneous fission rates against the parameter Z^2/A, which plays so important a part in the liquid drop theory of fission[3]. This is done in the accompanying graph. A number of the spontaneous fission rates are quoted only as upper limits, indicating, as a rule, that no fissions have been observed after a certain period of counting. This is shown in the diagram by a downward arrow from the point in question. The points for radium-226 and neptunium-239 have been omitted from the diagram, since there is reason for believing that the upper limits quoted are very much above the true values.

It will be observed, first, that all the spontaneous fission rates of the even–even isotopes lie, with one exception, very nearly upon a straight line. There are indications that this is actually a shallow curve, concave upwards, but the present data do not justify any estimate of its curvature. The exception of uranium-234 is so striking that the question of experimental error cannot be dismissed. Three separate counts have been made[1,4,5] upon two separate specimens of this isotope, and no fissions have been observed. The only possibility of error lies, therefore, in the preparation of the specimens and the estimation of the content of uranium-234.

The spontaneous fission rates of the odd–even and odd–odd isotopes are less than those of the even–even isotopes by several orders of magnitude. Experiments upon them are therefore more difficult and there are correspondingly fewer accurate data. There are, however, indications that the points for these isotopes lie upon two curves, and that the rates for the odd–even isotopes are in general lower than those for the odd–odd isotopes.

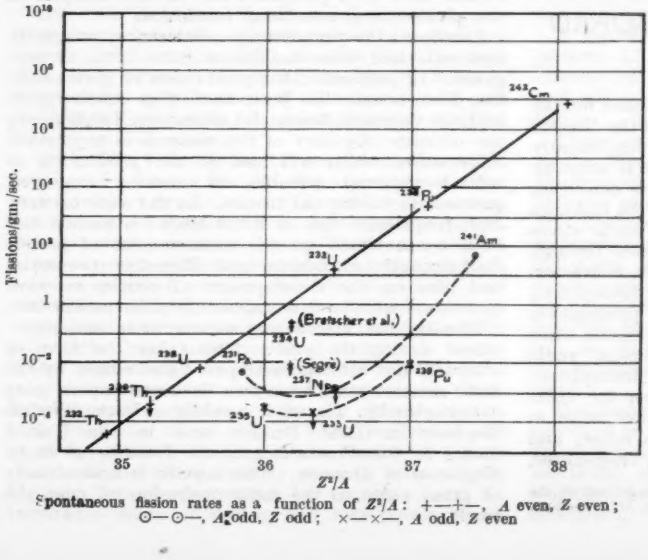
The method of plotting the spontaneous fission rates which has been employed here has the advantage of using only the experimental results and the parameter Z^2/A, which, while it is commonly employed in the liquid-drop model of the nucleus, is not related to the details of any particular theory. In fact, none of the current theories of fission appears to offer any explanation of the marked dependence of the spontaneous fission rate upon the exact number of protons and neutrons in the nucleus.

We have been given to understand that similar considerations have been put forward by Dr. Seaborg and his colleagues.

W. J. Whitehouse
W. Galbraith

Atomic Energy Research Establishment,
Harwell, Berks. Nov. 12.

[1] Segrè, E., *LADC* 975.
[2] Hanna, Harvey, Moss and Tunnicliffe, *Phys. Rev.*, **81**, 466 (1951).
[3] Bohr and Wheeler, *Phys. Rev.*, **55**, 426 (1939).
[4] Bretscher, Cook, Martin and Poole, British Report *BR* 384.
[5] Blanchard, Gofman and Seaborg (quoted by Segrè).



Spontaneous fission rates as a function of Z^2/A: +—+—, A even, Z even; ⊙—⊙—, A odd, Z odd; ×—×—, A odd, Z even

The Lotmar–Picken X-Ray Diagram of Dried Muscle

During the past twenty-five years, four samples of dried muscle have been made which show a striking X-ray diagram, with sharp diffraction maxima superimposed on the α-keratin pattern usually obtained from muscle. These samples of muscle were from the frog (sartorius muscle, Herzog and Jancke[1]), the mussel *Mytilus edulis* (Lotmar and Picken[2]; we have been informed by these authors that the muscle used was the anterior byssal retractor, rather than the posterior adductor, as stated in their paper), the scallop *Pecten* (adductor muscle, Bear and Cannan[3]), and the squid *Loligo* (funnel retractor muscle, Bear and Cannan[3]). Lotmar and Picken proposed a monoclinic unit of structure, with $a_0 = 11{\cdot}70$ A., $b_0 = 5{\cdot}65$ A., $c_0 = 9{\cdot}85$ A., $\beta = 73{\cdot}5°$, and they suggested that the crystalline substance, assumed to be protein, contains nearly extended polypeptide chains, parallel to the *b*-axis (the fibre axis), with two of these chains (four amino-acid residues) per unit cell. We have also discussed the X-ray pattern, on the assumption that the crystalline substance is a protein, and have suggested that the structure of the protein is that of the 3·7-residue helix[4].

Recently, Bear and Cannan[3], and also Bamford and Hanby[5], have pointed out that the length of the unit cell along the fibre axis is not 5·65 A. but only 5·2 A., and Bear and Cannan also have expressed serious doubt that the crystalline material is a protein. Some months ago, Dr. L. E. R. Picken and Dr. W. Lotmar kindly sent us their original photographs, and also their original sample of dried muscle. The sample of muscle no longer gives the crystalline pattern. On re-measuring the Lotmar–Picken photo-

graphs we have found, in agreement with the results of Bear and Cannan and of Bamford and Hanby, that the fibre-axis distance is indeed not 5·65 A., but approximately 5·3 A.

By comparing the photographs with photographs made by X-ray diffraction simultaneously from a horse hair and small needle-like crystals of urea (the urea simulating the crystalline part of the dried muscle samples), we have estimated that the samples producing the diagrams of the Lotmar–Picken type consist of about 10 per cent of crystalline material and about 90 per cent of ordinary protein with the α-keratin structure. This comparison accordingly does not eliminate the possibility that the crystalline material is non-protein substance, which is known to be present in dried muscle to the extent of, roughly, 10 per cent. Even though at the present time it is not possible to decide definitely whether the crystalline material is protein or non-protein, it is evident that it is a significant constituent of muscle, and that the detailed investigation of its structure should yield results of interest. We propose to continue work on this crystalline material.

It has already been found that the unit of structure suggested by Lotmar and Picken, even with the value of the axial length b_0 changed from 5·65 A. to 5·3 A., is not satisfactory. The reflexion with $k = 1$ and interplanar distance $d = 4·27$ A., and that with $k = 2$ and $d = 2·5$ A., reported by Bear and Cannan and present on the Lotmar–Picken photographs, require (with the new value of b_0) an $h0l$ plane with spacing 7·5 A., which is not given by the revised Lotmar–Picken unit. Without suggesting that another interpretation may not later be found to be the correct one, we point out that a unit twice the size of the revised Lotmar–Picken unit, with $a_0 = 23·4$ A., accounts for the observed reflexions ($d = 7·47$ A. for 300).

The revised value of b_0 is compatible with the α-helical configuration of polypeptide chains. We originally predicted[6] for this configuration a fibre-axis length per turn of about 5·44 A. This value is somewhat smaller than the Lotmar–Picken value of b_0, 5·65 A. In a detailed discussion of the helical configuration[7], we stated that the C—O . . . N distance 2·75 A. corresponds to 1·47 A. for the fibre-axis length per residue and that the C—C—N bond angle 108·9° corresponds to 3·60 residues per turn, these values being reasonable minimum values for the parameters. They lead to 5·29 A. for the length per turn of the helix, in agreement with the new value of b_0 for the crystalline material in the samples of dried muscle. Essentially the same value has been found experimentally for poly-γ-methyl-L-glutamate, in a study made in our laboratories by Mr. H. Yakel. He obtained the value 5·27 A. from layer-line separations on photographs of a well-crystallized fibre of this synthetic polymer, and also observed the spacing 1·47 A. for the Perutz 1·5-A. reflexion, which gives the length per residue. Thus, in these respects, as well as in the general aspect of the diagrams (as pointed out by Bamford and Hanby[8]), there is striking resemblance between the Lotmar–Picken diagram and the diagram of poly-γ-methyl-L-glutamate; this resemblance is the strongest evidence at the present time that the crystalline substance which produces he Lotmar–Picken diagram is a polypeptide of large molecular weight; that is, a protein.

(*Note added in proof.* Bamford and Hanby, in stating recently[8] that the 5·3-A. pitch for the α-helix might introduce difficulties by producing improbably short hydrogen bonds and reducing the axial translation per amino-acid residue to 1·47 A., have overlooked the fact that in our original discussion the values 1·47 A. for the axial translation per residue, corresponding to 2.75 A. for the hydrogen-bond length, and 3·60 for the number of residues per turn, corresponding to 108·9° for the carbon bond angle, were mentioned as reasonable. As stated above, these values lead to 5·29 A. for the pitch of the helix.)

We are indebted to Dr. W. Lotmar and Dr. L. E. R. Picken for lending us their sample and photographs, and to Dr. R. A. Pasternak and Dr. Lewis Katz for re-measuring the Lotmar–Picken films, to Dr. John E. Leonard for preparing the urea-horsehair diagrams, and to Mr. Harry Yakel for permission to quote his results for poly-γ-methyl-L-glutamate.

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[1] Herzog, R. O., and Jancke, W., *Naturwiss.*, **14**, 1223 (1926).
[2] Lotmar, W., and Picken, L. E. R., *Helv. Chim. Acta*, **25**, 538 (1942).
[3] Bear, R. S., and Cannan, C. M. N., *Nature*, **168**, 684 (1951).
[4] Pauling, L., and Corey, R. B., *Proc. U.S. Nat. Acad. Sci.*, **37**, 261 (1951).
[5] Bamford, C. H., and Hanby, W. E., *Nature*, **168**, 1085 (1951).
[6] Pauling, L., Corey, R. B., and Branson, H. R., *Proc. U.S. Nat. Acad. Sci.*, **37**, 205 (1951).
[7] Pauling, L., and Corey, R. B., *Proc. U.S. Nat. Acad. Sci.*, **37**, 235 (1951).
[8] Bamford, C. H., and Hanby, W. E., *Nature*, **169**, 120 (1952).

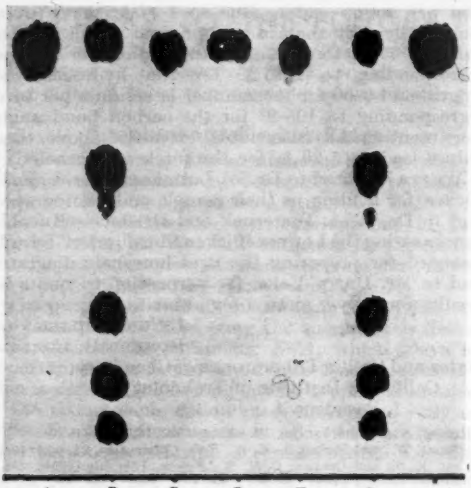
The C-Terminal Residue of Lysozyme

CARBOXYPEPTIDASE can split from peptide chains those terminal amino-acids that carry a free α-carboxyl group. The enzyme was used by Grassman *et al.*[1] in demonstrating that the C-terminal residue of glutathione is glycine, and by Lens[2] in studying the C-terminal residues of the peptide chains of insulin. Lens found that alanine is the end-group in two of the four chains of insulin, but was unable to identify the end-groups of the other two chains.

A previous study has indicated that the molecule of lysozyme has only one polypeptide chain[3]. It would therefore appear to be a particularly suitable protein for the study of its C-terminal residue by this technique. The N-terminal residue at the other end of the chain has already been shown to be lysine[4,5].

In a typical experiment, 11·3 mgm. lysozyme, 1·4 ml. water and 0·1 ml. of a suspension of commercial carboxypeptidase (containing 9–15 mgm./ml.) were mixed, the *p*H was adjusted if necessary to approximately 7·4 and the solution kept at 37° C. Aliquots of 0·3–0·4 ml. were taken at intervals and the liberated amino-acids separated from the protein, which otherwise caused interference in the subsequent chromatograms. Either the proteins were coagulated by heat and the supernatant solution removed or, adopting a method suggested by Partridge and described in the following communication, the amino-acids were absorbed on a cation-exchange resin, and after washing away the protein, they were displaced from the resin with ammonia. The amino-acid solution, containing in the second case excess ammonia, was evaporated to dryness and examined by paper chromatography. One-dimensional chromatograms, generally with butanol–acetic acid as solvent, were used.

The ion-exchange method is described in some detail as it is likely to find general application in the separation of amino-acids and small peptides from proteins, particularly in cases where it is desirable



Action of carboxypeptidase on lysozyme

A, Leucine control; *B*, control mixture of amino-acids showing (from bottom up) lysine, serine, alanine, tyrosine, valine, leucine; *C*, *D*, *E*, leucine liberated by the action of carboxypeptidase on lysozyme after 1¼, 4½ and 26½ hr., respectively, at 37° C.

to retain the protein intact and undenatured. Methods now in common use, such as precipitation with alcohol or trichloracetic acid, suffer from the disadvantage that the protein is denatured and the amino-acids may be adsorbed on the coagulum.

It is essential to use a resin of large particle size to reduce surface absorption of protein to a minimum and of a sufficient degree of cross-linkage to prevent entry of the large protein molecules to the inside of the resin particles.

In the present instance, approximately 50 mgm. sulphonated polystyrene resin was added for each 0·4 ml. of reaction mixture. (This represented a five-fold excess in terms of the capacity of the resin to absorb the amino-acid produced by complete liberation of one terminal residue from lysozyme.) The resin was regenerated before use by successive washings with 2 *N* hydrochloric acid, water, 2 *N* sodium hydroxide, water, 2 *N* hydrochloric acid and finally water until free from acid. The resin was shaken mechanically for one hour with the solution. The supernatant solution was then decanted and the beads washed once or twice with distilled water. The amino-acids were displaced from the resin with 5 *N* ammonium hydroxide (0·2 ml.) by shaking mechanically for a quarter of an hour and, after allowing the beads to settle, removing the supernatant solution.

Control tests showed that a little more amino-acid could be recovered from the resin by a further washing with ammonia and that, under these conditions, recovery was quantitative.

The results of the experiments were extremely clear-cut, showing that leucine was the first amino-acid to appear and the only amino-acid liberated in any quantity with reaction periods of up to 24 hr. (see photograph). Similar results were given by two different samples of crystalline lysozyme, one prepared by me, and the other obtained from a commercial source. Similar results were also given by the ion-exchange and heat-coagulation techniques.

That the spot was leucine and not *iso*leucine was clearly shown on a chromatogram run with water-saturated tertiary amyl alcohol as solvent in an atmosphere of diethylamine[6].

A semi-quantitative estimate was made of the recovery of leucine by the spot-dilution technique[7]. With a 4-hr. reaction period and using the heat coagulation procedure, the yield was 60 per cent of the calculated quantity based on the liberation of one residue of leucine from the lysozyme molecule.

It was originally hoped that, by following the liberation of other amino-acids during the reaction, the sequence of a number of residues along the chain from the leucine end-group could be revealed, an approach which is only possible when the molecule contains a single chain. However, the results were not clear-cut, since several amino-acids were liberated in small quantity almost simultaneously.

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[1] Grassman, W., Dycherhoff, H., and Eibeler, H., *Z. phys. Chem.*, 189, 112 (1930).
[2] Lens, J., *Biochim. et Biophys. Acta*, **3**, 367 (1949).
[3] Fraenkel-Conrat, H., *et al.*, *J. Amer. Chem. Soc.*, **73**, 625 (1951).
[4] Green, F. C., and Shroeder, W. A., *J. Amer. Chem. Soc.*, **73**, 1385 (1951).
[5] Thompson, A. R., *Nature*, **168**, 390 (1951).
[6] Work, E., *Biochem. J.*, **42**, xlix (1948).
[7] Fisher, R. B., Parsons, D. S., and Morrison, G. A., *Nature*, **161**, 764 (1948).

Ion-Exchange Resins as Molecular Sieves

Synthetic ion-exchange resins of the sulphonated polystyrene type consist essentially of a cross-linked hydrocarbon skeleton to which the functional groups (nuclear sulphonic acid residues) are attached in a rather uniform manner. In water, the resin swells to a degree depending upon the degree of cross-linkage, and thus the size of the pores in the swollen resin gel can be adjusted by varying the proportion of divinylbenzene used in the preparation of the polymer[1].

It has been shown, particularly by Richardson[2,3], and Kunin[4], that diffusion of charged particles into the resin gel is markedly selective for cations of different size, and, in fact, a suitably cross-linked exchange resin can be used as a 'molecular sieve' for the purpose of screening ions of small diameter from a solution containing larger solutes.

This procedure has many practical uses in biochemical work, when it is frequently necessary to separate small ions from admixture with substances of higher molecular weight (cf. Deuel *et al.*[5]). The process is, of course, similar to that of dialysis; but it may be used on a much smaller scale, and has the additional advantage that by suitable choice of resins it can be made selective for cations, anions or ampholytes. Separations based on this principle have been employed with success in this laboratory on several occasions during the past year; but the procedure described in the preceding communication by A. Thompson illustrates its usefulness where the quantities of material involved are small.

In any such separation the larger ionic species must, of course, be adsorbed to some extent on the surface of the resin particles; but by choosing a resin in the form of large spherical beads, the surface may be reduced to a minimum. The sample of resin used for the separation of amino-acids and lower peptides from proteins was a sulphonated cross-

linked polystyrene in bead form, 15–30 mesh/in. Its water regain at saturation was 0·75 gm. water per gm. dry H^+ resin, which corresponds to a nominal divinylbenzene content of 10–12 per cent[1].

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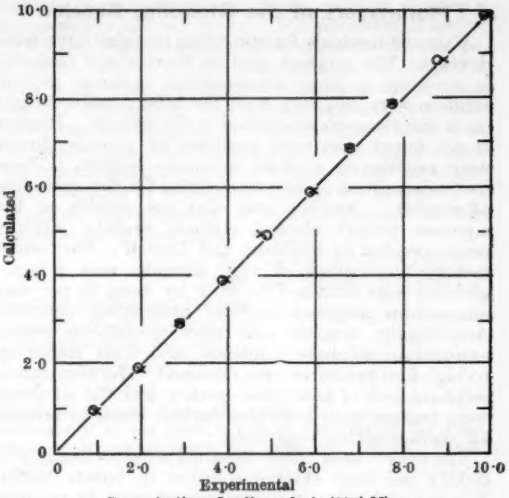
[1] Pepper, K. W., *J. App. Chem.*, **1**, 124 (1951).
[2] Richardson, R. W., *Nature*, **164**, 916 (1949).
[3] Richardson, R. W., *J. Chem. Soc.*, 910 (1951).
[4] Kunin, R., *Anal. Chem.*, **21**, 87 (1949).
[5] Deuel, H., Solms, J., and Anyas-Weisz, L., *Helv. Chim. Acta*, **33**, 2171 (1950).

Determination of Sodium Oleate in Dilute Aqueous Solution

THERE is no simple, satisfactory method for determining small amounts ($< 10^{-3}$ *M*) of carboxylic soaps in aqueous solution. On the other hand, there are several methods of estimating synthetic ionic detergents, such as long-chain alkyl sulphates and quaternary ammonium salts. Of particular interest is the method of Epton[1], in which the titration of anionic against cationic detergent is carried out using a partition end-point with methylene blue as indicator. We have now found that sodium oleate can be estimated by a modification of this method, if certain precautions are taken. Considerations of solubility led us to choose sodium oleate to illustrate the method, although it is clearly applicable to other soaps of similar constitution.

A dilution series of aqueous sodium oleate was prepared in the range $1{\cdot}0 \times 10^{-3}$ *M* down to $1{\cdot}0 \times 10^{-4}$ *M*. The solutions were maintained at *p*H 10 by the presence of an excess of sodium hydroxide. Should the *p*H fall appreciably below this, the presence of 'acid soap' invalidates the method. 10·0 ml. of $5{\cdot}0 \times 10^{-4}$ *M* cetyl trimethyl ammonium bromide was run into a 50-ml. stoppered cylinder containing 10 ml. chloroform. The oleate solution was then added from a burette, with frequent shaking. As the end-point was approached, the stability of the emulsion increased. Near the end-point, 0·2 ml. of aqueous methylene blue solution (0·05 per cent) was added. The true end-point was obtained when the intensity of the dye colour in the chloroform phase became equal to that in the aqueous phase, as viewed against a background of diffuse light. The methylene blue in the chloroform phase becomes pink within about one minute after its addition, due to the presence of the alkali in the aqueous phase. Since the development of this pink colour tends to mask the end-point, the addition of the indicator must be delayed as long as possible. Accurate and reproducible results could only be obtained by delaying the addition of indicator until a marked increase in emulsion stability was observed; at this stage, the titration was about 95 per cent complete. The accompanying graph illustrates the precision of the method (circles).

As an independent means of estimating the oleate concentrations, we have developed a method based on the Langmuir surface balance. Using a micrometer-syringe, a known volume of the soap solution was spread on a continuous recording surface-balance[2] containing, as substrate, a 25 per cent ammonium sulphate solution which was 0·01 *N* with respect to sulphuric acid. By measuring the collapse area of the derived oleic acid monolayer, it was possible to determine the oleate solution concentration. Results are shown in the graph (crosses).



Comparison of titration methods for sodium oleate determinations: O, by partition titration; ×, by surface balance technique. The straight line represents the theoretical for zero experimental error

Both methods are accurate to ± 1 per cent. From the graph, it can be seen that they give the correct, calculated end-point over the whole of the investigated range.

Since the cetyl trimethyl ammonium bromide/oleate titration method is based, fundamentally, on the formation of a complex between the cationic and anionic long-chain radicals, the presence of any undissociated fatty acid will interfere with the observed end-point. It is clear, therefore, that the sodium oleate solution must be sufficiently alkaline to ensure virtually complete ionization of the fatty acid. Thus, Epton (*loc. cit.*) has remarked, and we have confirmed, that neutral (*p*H 8) solutions of oleate cannot be estimated by the partition method. We have found that a *p*H of (at least) 10 is necessary for complete fatty acid ionization and, hence, for obtaining the correct end-point. It is also of interest, in connexion with the surface-balance method, that unless the *p*H of the spreading solution is (at least) 10, complete spreading of the monolayer does not occur.

As might be expected, the partition titration method is affected by calcium ions (0·01 *M*) present in the soap solution, due to the formation of un-ionized calcium oleate. Similarly, copper ions (0·005 *M*) destroy the end-point by precipitating the basic copper oleate.

The cetyl trimethyl ammonium bromide solution was standardized by partition titration against pure sodium dodecyl sulphate.

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[1] Epton, *Trans. Farad. Soc.*, **44**, 226 (1948).
[2] Glazer and Alexander, *Trans. Farad. Soc.*, **47**, 401 (1951).

Monolayers of the Globulin, Arachin

Various methods for spreading proteins have been devised. The method used by Gorter and Grendel[1] is to drop a fairly concentrated aqueous protein solution very carefully from the least possible height on to the clean water surface in the trough. Hughes *et al.*[2] found that solid particles of protein spread very rapidly on a clean substrate surface. These methods proved to be unsuccessful for the spreading of arachin. Arachin was also not soluble in the aqueous propyl alcohol – sodium acetate mixture recommended by Ställberg and Teorell[3]. Very satisfactory monolayers of egg albumin and β-lactoglobulin were obtained by Bull[4] by using 35 per cent ammonium sulphate as the underlying solution. Accordingly, arachin was next spread on strong ammonium sulphate solutions, and films stable up to high film pressures were obtained. The ammonium sulphate was of analytical quality and the solutions were treated with activated carbon black to remove all surface-active impurities.

The force – area curve obtained when 0·10 c.c. of a 0·0271 per cent arachin solution in borate buffer, $I = 0{\cdot}1$ and $p\mathrm{H} = 8{\cdot}9$, was spread on a 40 per cent ammonium sulphate solution, is shown in Fig. 1. The time elapsing between spreading and the start of compression was 10 min. A typical protein film was obtained. It is of interest to note that no collapse of the film was observed at a force as high as 27 dynes/cm. This force corresponds to a film area of 0·43 sq. m. per mgm., a value which was obtained consistently. Bull[5] reported an average value of 0·78 sq. m. per mgm. as the smallest area to which most of the reported films can be subjected and remain uncollapsed. It would therefore appear that arachin films may be compressed to very small areas and remain uncollapsed.

The graph of force × area (FA) against force (F) for arachin films is shown in Fig. 2, and the resulting equation is :

$$FA = 0{\cdot}818F + 0{\cdot}100.$$

The extrapolated value of FA at zero film pressure is, accordingly, 0·100 ergs and the film molecular weight $24{\cdot}6 \times 10^3/0{\cdot}100 = 24{,}600$. The bulk molecular weight of the parent arachin molecule is 340,000[6]. In an earlier paper[7] dissociation of arachin into two sub-units was observed. It would therefore

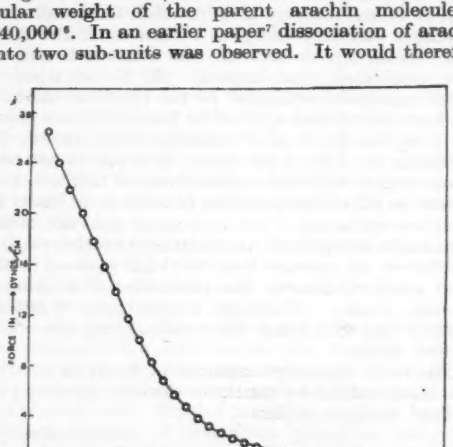

Fig. 1. Force – area curve for arachin films on 40 per cent ammonium sulphate

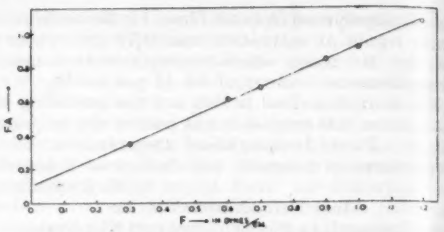

Fig. 2. Film-pressure multiplied by the corresponding film-area plotted against the film pressure

appear that, when arachin is spread on a surface, unfolding of the globular molecule is followed by dissociation into relative small fragments. Several reports have been recorded of dissociation of proteins when spread on a surface[8].

A similar breakdown has been observed when arachin was treated with the sodium salt of long-chain paraffin sulphates[3]. Calculations from sedimentation and diffusion data have shown that complexes with the detergents have been formed, in which the weight of protein per molecule of complex is about 27,000. This is approximately the same as the surface molecular weight, and suggests that both surface spreading and complex formation have dissociated the arachin molecule in a similar manner.

This communication is published with the permission of the South African Council for Scientific and Industrial Research. I am greatly indebted to Sir Eric Rideal, in whose laboratory the work was undertaken, for his interest and criticism at all times.

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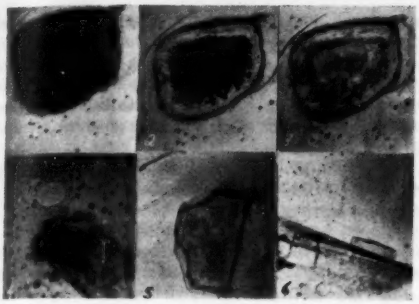
[1] Gorter, E., and Grendel, F., *Proc. K. Akad. Amsterdam*, **29**, 371 (1925).
[2] Hughes, A. H., Schulman, J. H., and Rideal, E. K., *Nature*, **129**, 21 (1932).
[3] Ställberg, S., and Teorell, T., *Trans. Farad. Soc.*, **35**, 1413 (1939).
[4] Bull, H. B., *J. Amer. Chem. Soc.*, **67**, 10 (1945).
[5] Bull, H. B., "Advances in Protein Chem.", **3**, 95 (1947).
[6] Johnson, P., and Shooter, E. M., *Biochim. et Biophys. Acta*, **5**, 361 (1950).
[7] Johnson, P., *Trans. Farad. Soc.*, **42**, 36 (1946).
[8] Johnson, P., and Joubert, F. J., *J. Polymer Sci.*, **7**, 605 (1951).

A Method of Preparing Crystals that Undergo Changes under Electron Bombardment in an Electron Microscope

Observations of pseudo-structures in the electron microscope have been reported by several authors. This phenomenon has been fully reported by Burton *et al.*[1] and by Watson and Preuss[2] for sodium chloride crystals. We have devised a reproducible method for the preparation of sodium chloride crystals which undergo such changes in an *RCA* electron microscope, model *EMU*, fitted with an unbiased gun. It was observed that crystals obtained by drying aqueous solutions of sodium chloride of analytical-reagent grade rarely showed the effect. Hence it was thought that the change was facilitated by a favourable crystalline habit of the sodium chloride. This favourable habit was obtained by adding formalin and calcium chloride to the aqueous solution of sodium chloride and drying this solution under given conditions. Formalin was added to the sodium chloride solution because it had been observed



Figs. 1, 2, 3. A crystal submitted to the electron beam, showing a loss of opacity from the periphery to the centre
Fig. 4. A crystal, after the change, surrounded by particles of geometrically defined shape
Fig. 5. A crystal, after the change, showing a dense outer envelope
Fig. 6. A crystal, after the change, the profile of which is visible due to the breaking of the supporting collodion film

× 3,750

that it produces the liquid inclusions necessary for the observation of the changes in sodium chloride crystals. The idea of adding calcium chloride was suggested by the paper of Bunn and Emmett[3], who dealt with the property exhibited by calcium chloride of making uniform and thickening the layers of sodium chloride crystals when they are forming, thus maintaining, as we believe, the liquid inclusions under the vacuum of the electron microscope.

The solution with which the best results were obtained was prepared by adding 100 ml. of Bakers *CP* formalin to 1 litre of a solution containing 17 gm. of sodium chloride and 0·6 gm. of calcium chloride in twice-distilled water. The salts were of the analytical reagent grade.

Drops of this solution were put on the usual collodion-coated, electron microscope screens, which in turn were placed on chemically clean glass slides. Drops were delivered by capillary pipettes and the diameter of the drops did not exceed the grid diameter, thus yielding drops with approximately spherical profile. It was observed that without further treatment these drops would afford crystals too large for the demonstration of the phenomenon. Thus, the drops were touched with an empty capillary pipette, which left a drop the profile of which was scarcely perceptible. The glass slides were then placed in an incubator with anhydrous calcium chloride to ensure a decreased air humidity at the temperature of 37° C. After ten minutes, the preparation was ready to be examined in the electron microscope. To avoid loss of crystals when the vacuum is made in the electron microscope and in order to observe the phenomenon better, the screen must be placed so that the crystals lie between the collodion film and the electron gun.

With crystals prepared according to this method, the change occurs at an electron beam intensity of 0·5 m.amp. Sometimes 0·2 or 0·3 m.amp. was enough for small crystals. Figs. 1, 2, 3 show that the crystals lose their opacity from the periphery towards the centre, in a sequence contrary to that reported by Watson and Preuss[3]. A sudden decrease in the electron beam intensity stopped the change, as can be seen in these photographs. In Fig. 3 there appears to be another envelope, of fibrous structure, which lies at the outer zone of the central opaque mass. In Fig. 4 the crystal is surrounded by particles apparently ejected from it. These, usually, showed a geometrically defined shape. The primitive shape of the crystals was generally maintained after the change, as can be seen in all the photographs. In Fig. 5 a dense outer envelope can be seen around the crystals after the change. In Fig. 6 there appears in profile, due to the breaking of the supporting collodion film, a crystal which had been subjected to the change. This is interesting, because it indicates that the shape of the crystals is preserved during the change.

Further investigation of the mechanism of the phenomenon is now under way.

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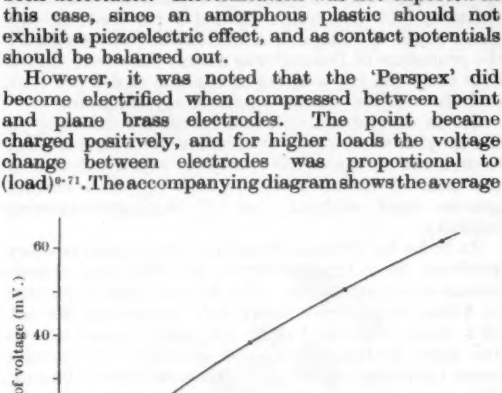
[1] Burton, E. F., *et al.*, *Nature*, **160**, 565 (1947).
[2] Watson, J. H. L., and Preuss, C. E. S., *J. App. Phys.*, **21**, 904 (1950).
[3] Bunn, C. W., and Emmett, H., Farad. Soc. Discuss., "Crystal Growth", **5**, 119 (1949).

Electrification of 'Perspex' under Compression

The use of plastics such as polystyrene, polythene, and polymethyl methacrylate ('Perspex') as insulating media for cable and supports in the grid lead of electrometer-valve measuring devices is complicated by the appearance of spurious charges arising from friction and mechanical stress of the insulator.

We have studied the charging of 'Perspex' under compression using an electrometer of 2 mV./division sensitivity. With a uniform stress of up to 500 gm./cm.^{2} applied to a specimen between parallel plate electrodes, no charging could be detected once frictional electrification had been eliminated. The total capacity between electrodes was only 13 pF., so that charges of $2{\cdot}5 \times 10^{-14}$ coulomb should have been detectable. Electrification was not expected in this case, since an amorphous plastic should not exhibit a piezoelectric effect, and as contact potentials should be balanced out.

However, it was noted that the 'Perspex' did become electrified when compressed between point and plane brass electrodes. The point became charged positively, and for higher loads the voltage change between electrodes was proportional to (load)$^{0{\cdot}71}$. The accompanying diagram shows the average



Variation of voltage change on application of load to point and plane electrodes

voltages produced, as scatter of the readings was caused by movement of the point. The voltage was dependent on the shape of the point, the tip radius in this case being about 0·2 mm.

A possible explanation of the above effect is as follows. At the metal – insulator contacts the difference of the Fermi-level of the metal, and surface or impurity levels in the dielectric, causes a flow of electrons from the metal to the dielectric. Due to the insulating property of the plastic, the charge transference is proportional to the actual contact area. When loaded, the electrodes are charged by different amounts due to the differential change of contact area, and so there is a change of voltage across the specimen. Hardness tests show that the area of indentation caused by concentrated loads on solid surfaces is proportional to $(\text{load})^n$, where n is between 0·6 and 1·0.

To test this hypothesis, a relatively large change of contact area for a small load was obtained by using a bead of mercury as the top electrode. Voltages of the same order as previously were produced by spreading the mercury over the surface with slight pressure.

Work is continuing on this problem, using more controlled conditions and carefully prepared surfaces.

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Aerobic Decomposition of Chitin by Micro-organisms

From manured garden soil two strains of chitinovorous bacteria have been isolated on agar plates of the following composition: chitin (finely ground), 1 per cent; dipotassium hydrogen phosphate, 0·1 per cent; magnesium sulphate, 0·1 per cent; calcium chloride, 0·03 per cent; agar, 1·5 per cent, in tap water; *p*H 7. The chitin was made from shrimps; the procedure of Benton[1] was mainly followed. Chitin thus prepared has a nitrogen content of 6·9 per cent and showed the characteristic X-ray diagram.

Chitin decomposition could be readily detected on the greyish-white agar, as chitinovorous strains form clear zones around their colonies. Stock cultures of the isolated strains could be kept on yeast extract glucose agar without loss of chitin-decomposing capacity.

In order to obtain information about intermediary products in chitin breakdown the following experiments were carried out. The strains were inoculated in 3-litre Erlenmeyer flasks, each containing 300 ml. of a liquid medium having the same composition as the agar medium mentioned above. The cultures were incubated at 30° C. with continuous shaking. One strain (still unidentified) showed rather slow decomposition of chitin, whereas the other (belonging to the genus *Corynebacterium*) attacked the chitin very rapidly, 3 gm. of chitin disappearing completely within three days.

At successive stages of decomposition of the chitin the culture liquids were treated as follows. After centrifugation, the liquid was filtered through a porcelain filter in order to remove all bacteria. Then the filtrate was evaporated *in vacuo*; the remaining 4–5 ml. were used for chromatographic analysis. Filter-paper chromatograms were made using strips of Whatman No. 1 filter paper, with collidine and phenol as solvents. Use was made of the following spraying reagents: ninhydrin, aniline hydrogen phthalate (Partridge[2]) and the hexosamine reagents (Partridge[3]).

In the culture liquids of both strains, acetylglucosamine as well as glucosamine appeared to be present. As the spots were rather faint, an attempt was made to accumulate intermediary products by checking growth in two ways. After initial incubation as mentioned above, some cultures of each strain were kept at 45°, the cultivation of others being continued under anaerobic conditions in a nitrogen atmosphere at 30° C. Then the culture liquids were treated as before. Under these conditions, culture liquids of both strains gave heavy spots of acetylglucosamine and glucosamine, showing that hydrolysis of chitin and subsequent deacetylation of acetylglucosamine had continued under conditions in which growth of bacteria was inhibited.

The appearance of acetylglucosamine and glucosamine in the chitin cultures was coupled with the formation of acetic acid and ammonia. The formation of ammonia makes it probable that glucosamine is deaminated by both strains; glucose, however, could not be found in the culture liquids.

Further studies on chitin decomposition are in progress.

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[1] Benton, A. G. *J. Bact.*, **29**, 449 (1935).
[2] Partridge, S. M., *Nature*, **164**, 443 (1949).
[3] Partridge, S. M., *Biochem. J.*, **42**, 238 (1948).

Effect of Purines on the Multiplication of Plant Viruses

It has recently been shown[1] that the substituted purine, 5-amino-7-hydroxy-I-V-triazolo (D) pyrimidine (guanazolo), when sprayed on the leaves of plants delays or inhibits, within the plant, the development of certain virus infections. Subsequent work, reported briefly here, has shown that hypoxanthine, adenine and guanine reverse the activity of guanazolo, while other naturally occurring purines do not. The triazolo analogue of hypoxanthine also shows some virus-inhibitory activity.

In reversal experiments, compounds were sprayed on the leaves before inoculation. Effects were measured by the number of local lesions produced and by the numbers and time of development of systemic infections.

Using lucerne mosaic virus in *Nicotiana glutinosa* or *N. tabacum*, it was found that adenine, guanine and hypoxanthine at 0·01 *M* concentration reversed the activity of guanazolo (0·005 *M* in 0·1 per cent sodium bicarbonate), whereas xanthine, uric acid, theobromine, theophylline, caffeine, uracil, thymine and urea did not. Of the three purines which showed reversing activity, hypoxanthine was the most effective. However, the possible effects of guanine have not yet been adequately tested, since the compound has no detectable effect when applied in suspension in water, while at the *p*H at which it

goes into solution some damage is produced on sprayed leaves. Guanosine, the only nucleoside so far tested, showed some reversing activity. In plants treated with guanazolo plus adenine or guanine, the numbers of local lesions and amount and rate of systemic spread, although significantly greater than in plants treated with guanazolo only, were not as great as those in control plants. However, in some experiments hypoxanthine not only reversed the activity of guanazolo but also increased the number of local lesions and rate of systemic spread above that of the controls.

To test the effect of hypoxanthine *in vitro* on infectivity, lucerne mosaic virus in expressed *N. glutinosa* sap (1 volume) was incubated with 0·016 *M* hypoxanthine (9 vol.) or with water (9 vol.) for 2 hr. at room temperature. On inoculation to tobacco, no significant difference in number of local lesions was found between water and hypoxanthine treatments. It is probable, therefore, that the added hypoxanthine is utilized in some way in virus synthesis.

Further experiments have been carried out to test this possibility. The increase in tobacco mosaic virus in inoculated leaves of *N. tabacum* was followed during 0–72 hr. after inoculation, the amount of virus being measured by the number of local lesions produced in *N. glutinosa*. It was found that two sprays of 0·01 *M* guanazolo before inoculation delayed, while a similar treatment using hypoxanthine hastened, the production of infective virus.

The results of reversal experiments with hypoxanthine suggested that the triazolo analogue of hypoxanthine might have some virus-inhibitory activity. Preliminary tests with this compound (7 hydroxy-I-V-triazolo (D) pyrimidine) have been made, using the lucerne mosaic virus. In *N. glutinosa* the compound shows some activity, being not quite as effective at 0·03 *M* as guanazolo at 0·01 *M* concentration. However, in *Phaseolus vulgaris* (var. Canadian Wonder) the hypoxanthine analogue (at 0·03 *M*) was much more effective than guanazolo (at 0·01 *M*) in reducing the number of local lesions produced by lucerne mosaic virus, mean numbers of local lesions per leaf being 52 for control, 24 for guanazolo and 2·3 for the hypoxanthine analogue. Guanazolo caused stunting and yellowing in beans, but the hypoxanthine analogue had no apparent effect on this host. These results indicate that the host plant as well as the virus may be important in determining the effectiveness of a particular compound.

The results suggest the possibility that the viruses tested may be able to utilize free adenine and guanine, and that hypoxanthine may be a precursor of guanine and perhaps adenine in normal virus synthesis. It is possible that guanazolo may act either by interfering with the incorporation of guanine and perhaps adenine into the virus, or by being built directly into the virus in place of guanine.

My thanks are due to Dr. J. Ploeser, Otago Medical School, for a sample of guanosine, and to the Lederle Laboratories Division, American Cyanamid Company, for supplies of the triazolopyrimidines.

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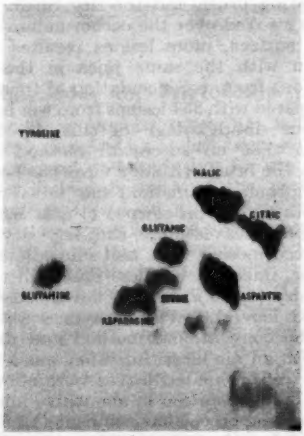
[1] Matthews, R. E. F., *Nature*, **167**, 892 (1951).

Fixation of Carbon Dioxide by Barley Roots

The uptake of carbon dioxide by plant root preparations has been demonstrated by various workers[1–4]. In addition to confirming the fact of fixation, I have investigated the effect of a number of factors involved and the compounds in which the absorbed carbon appears, using carbon-14.

Excised barley roots, from seedlings one week old grown in tap water, were exposed to carbon-14 dioxide while supported in phosphate buffer at *p*H 5·6 in a closed vessel, the radiocarbon being administered as $NaH^{14}CO_3$. Following the period of exposure, the buffer solution was decanted off, the roots were rinsed rapidly with distilled water and boiling 80 per cent ethanol added. The material was ground thoroughly in a mortar with a pestle, and quantitative transfer of liquid and solid matter made into a graduated cylinder. Aliquots of 100 μl. each of centrifuged extract were plated and counted using a thin-window Geiger tube, whence the radioactivity of the total volume of extract was derived. Concentration of the clear extract to a volume of 1–2 ml. by vacuum distillation followed, from aliquots of which two-dimensional chromatograms on Whatman No. 1 filter paper were prepared, using phenol – water and butanol – propionic acid – water as solvents. Radioautographs were produced by exposure of Eastman 'No Screen' X-ray film to the chromatograms.

The following results were obtained: (1) Under virtually anaerobic conditions, the uptake of carbon-14 was reduced to a very low value, depending upon the efficiency of oxygen displacement. (2) When, after excision, the root material was held in aerated Hoagland solution for 24 hr. before exposure to carbon-14 in phosphate buffer, only approximately one-fifth as much activity was incorporated as when tap or distilled water was substituted for the nutrient solution. (3) In experiments involving various exposure times, uptake of carbon-14 dioxide rapidly declined after 10 min., only a slow rate of fixation occurring between 30 min. and 60 min. (the longest period studied). (4) The principal, non-volatile, 80 per cent ethanol-soluble compounds found to be



Radioautograph showing radioactive, 80 per cent ethanol-soluble products of 60 min. fixation of carbon-14 dioxide by excised barley roots. The chromatogram from which this radioautograph was prepared was run horizontally in phenol – water and vertically in butanol – propionic acid – water

radioactive were malic, citric (or *isocitric*), aspartic and glutamic acids, asparagine, glutamine, serine and tyrosine, with traces (in some experiments) of α-ketoglutaric acid, alanine and several as yet undetermined compounds. A typical radioautograph is reproduced herewith.

Radioactivity has also been found to be present in insoluble products, which are being investigated.

A full account of this work, which was sponsored by the United States Atomic Energy Commission, will be published elsewhere.

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Oct. 29.

[1] Ruben, S., and Kamen, M. D., *Proc. U.S. Nat. Acad. Sci.*, **26** (1940).
[2] Overstreet, R., Ruben, S., and Broyer, T. C., *Proc. U.S. Nat. Acad. Sci.*, **26** (1940).
[3] Gollub, M. C., and Vennesland, B., *J. Biol. Chem.*, **169** (1947).
[4] Vennesland, B., Cetthaml, J., and Gollub, M. C., *J. Biol. Chem.*, 171 (1947).

Deleterious Action of Water in Plant Virus Inoculations

Although water is commonly used as the suspending medium for the plant juice in successful mechanical inoculations with viruses, recent results indicate that the water *per se* actually interferes with infection. Most of the evidence to be presented is derived from inoculations of tobacco mosaic virus on bean (*Phaseolus vulgaris*); but corroborative evidence on most aspects of the work has resulted from inoculations with tobacco necrosis virus on bean, and spotted wilt virus on tobacco (*Nicotiana tabacum*). In recording results, the numbers of infections given are local lesions on comparable areas of control and treated leaves. All types of trials were repeated three or more times. All inoculations were with the aid of carborundum powder. A 0·1 per cent suspension of ground leaf tissue in water was usually the inoculum.

When the inoculum in water was allowed to dry in an inoculating brush and the dry brush with dried virus then stroked over the carborundum-dusted dry bean leaf surface, more lesions resulted than from inoculation with the same juice in the wet state (1,145 lesions from dry inoculation of tobacco mosaic virus compared with 357 lesions from wet inoculation). The serious disadvantage of this dry inoculation method is that no successful method of quickly recharging the brush with dry virus has been devised. The dry inoculation method has failed with white clover mosaic virus on cowpea (*Vigna senensis*).

When bean leaves were similarly dry-inoculated with tobacco mosaic virus and immediately sprayed with water, infection was less than when the leaves were left dry (1,290 lesions on unwashed against 200 on washed leaves). When leaves were inoculated wet by the conventional method and dried within 10 sec. with an air blast, infection was heavier than when the wet-inoculated leaves were allowed to dry naturally by evaporation in about five minutes to an hour, depending on the environment (1,740 lesions on quick-dried leaves against 242 on slow-dried leaves with tobacco mosaic virus on bean, 208 against 24 for spotted wilt virus on bean, and 172 against 44 for spotted wilt virus on tobacco).

When carborundum-dusted bean leaves were brushed with a clean dry brush and then dipped in inoculum, infection was greater than when the leaves were brushed with a wet brush and then dipped in inoculum (297 lesions on leaves rubbed dry against 37 on leaves rubbed wet for tobacco mosaic virus on bean, and 104 against 18 for tobacco necrosis virus on bean).

When detached bean leaves were dried (wilted) to 90–95 per cent of their original green weight before wet inoculation, the number and size of the lesions were greater on the wilted than on the non-wilted leaves (712 lesions on wilted against 181 on turgid leaves). When detached leaves were wilted to 65–95 per cent of their original green weight after wet inoculation, the number and size of the lesions was greater than on non-wilted leaves (5,710 lesions on wilted against 2,452 lesions on turgid leaves for tobacco mosaic virus and 265 against 48 for tobacco necrosis virus). The data on wilting are in accord with those of Howles[1] for natural infection with tomato mosaic.

The above results are in accord with the hypothesis that water is injurious to the early phases of the infection process with certain viruses.

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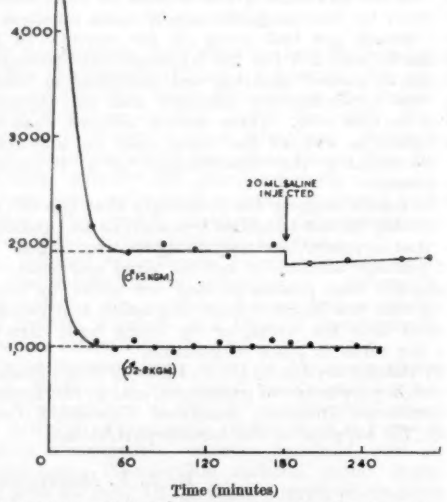
[1] Howles, R., Cheshunt Exp. Res. Sta. Report, 1948, 22 (1949).

Measurement of Total Body-water with Urea

Total body-water in the intact animal is usually measured by dilution methods. In these, determinations are made of the volume of fluid in which a known amount of some freely-diffusible substance distributes itself in the body. Urea which, with the exception of some of the fluids of the kidney and the



Radioactivity of blood after injection of carbon-14 urea ($2{\cdot}13 \times 10^6$ counts/min.)

Radioactivity of blood after intravenous injection of carbon-14 urea ($2{\cdot}13 \times 10^6$ counts/min.) into fasted cats with their ureters tied. Upper curve: lean male cat, 1·5 kgm. body wt.; body-water, 64·6 per cent. Lower curve, lean male cat, 2·8 kgm. body wt.; body-water, 65 per cent

renal veins and the possible exception of the cerebro-spinal fluid[1] and blood cells[2], is uniformly distributed in the body fluids, has recently been used for body-water measurements in dogs[3], humans[4–6], rats[7] and cats[8].

In these experiments, relatively large amounts of urea were administered, and it was assumed that these amounts caused no diuresis, and no change in urea clearance or in the rate of formation of urea in the body which might vitiate the results. These assumptions become unnecessary when radioactive urea is used, because it is administered in negligibly small quantities. In the course of studies on the metabolism of urea labelled with carbon-14[7] values were obtained for the total body-water of fasted cats. The ureters were tied to avoid loss of urea, and it was found that in these experiments the breakdown of urea by gastric urease or bacterial action[6] was negligible. The results (see graph) show that the body-water of these cats was 65 per cent of the body weight, in good agreement with values obtained by other methods[6,8]. This shows that the assumptions inherent in the use of non-isotopic urea are justified, and therefore that urea is a suitable substance for the rapid and accurate determination of total body-water.

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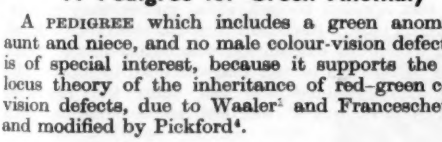
[1] Myers, V. C., and Fine, M. S., *J. Biol. Chem.*, **37**, 329 (1919). Cockrill, J. R., *Arch. Neurol. Psychiat.*, **25**, 1297 (1931). Leopold, J. S., and Bernhard, A., *Amer. J. Dis. Child.*, **13**, 34 (1917). Fremont-Smith, F., Lalley, M. E., Merritt, H. H., Carroll, M. P., and Thomas, G. W., *Arch. Neurol. Psychiat.*, **25**, 1271 (1931).
[2] Ralls, J. O., *J. Biol. Chem.*, **151**, 529 (1943).
[3] Painter, E. E., *Amer. J. Physiol.*, **129**, 744 (1940).
[4] Steffensen, K. A., *Acta Physiol. Scand.*, **13**, 282 (1947).
[5] McCance, R. A., and Widdowson, E. M., *Proc. Roy. Soc.*, B, **138**, 115 (1951).
[6] McCance, R. A., and Widdowson, E. M., *Brit. Med. Bull.*, **7**, 297 (1951).
[7] Kornberg, H. L., Davies, R. E., and Wood, D. R., Proc. 1st Isotopes Techniques Conf., 1951 (in the press).
[8] Moore, F. D., *Science*, **104**, 157 (1946).

A Pedigree for Green Anomaly

A PEDIGREE which includes a green anomalous aunt and niece, and no male colour-vision defectives, is of special interest, because it supports the two-locus theory of the inheritance of red–green colour vision defects, due to Waaler[1] and Franceschetti[2,3], and modified by Pickford[4].



In the first generation shown in this pedigree, there is a woman who is typically green anomalous. She has a sister and a brother whose colour vision is quite normal. Her other sister has a marked green deviation, and, according to the most probable expectation for a woman green deviant who has a green anomalous sister, she is a normal heterozygote for green anomaly[5]. Her husband has normal colour vision; but their daughter, shown in the second generation, is green anomalous.

In the first generation, the normal brother's wife shows the red-green weakness characteristic of normal heterozygotes for deuteranopia[5]. They have two sons with normal colour vision and one daughter, who, like her mother, is red-green weak, and most probably an ordinary deuteranope heterozygote. This is in accordance with the sex-linked pattern of inheritance for colour blindness, and the sons were as likely to be deuteranopes as normal.

The problem, however, is to account for the inheritance of green anomaly by the daughter of a normal man and a woman who is a heterozygote for this condition. On the single locus theory this would be explained as an exceptional heterozygous manifestation[6]; but why the exception? On the two-locus theory it is likely that the father was really a double-defective genotype (such as *pd*/––, using the notation I have suggested[4]). If he carried the protanope and deuteranope genes, or those for red and for green anomaly, together but on different loci, it would be expected, in accordance with data set forth by Waaler, Franceschetti and others, that these genes would neutralize each other's effects, and that he would have colour vision of normal phenotype. His daughter, who is green anomalous, would be a double heterozygote (such as *pd*/*Ng*), in which the gene for green anomaly would determine the phenotype, since the protanope and deuteranope genes would still neutralize each other.

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[1] Waaler, G. H. M., *Z. ind. Abs. und Ver.*, **45**, 279 (1927).
[2] Franceschetti, A., *Sweiz. Med. Wschr.*, **58**, 1273 (1928).
[3] Franceschetti, A., *Bull. Acad. Suisse Sci. Med.*, **5**, 227 (1949).
[4] Pickford, R. W., "Individual Differences in Colour Vision", 361 (1951).
[5] Pickford, R. W., "Individual Differences in Colour Vision", 335 (1951).
[6] Ford, E. B., "Genetics for Medical Students", 151 (2nd edit., 1946)

Fungicides and Phytotoxicity

2 : 3-DICHLORONAPHTHAQUINONE (I) is known to be an effective fungicide. It has been shown to be of value as a seed dressing[1]; but its use on foliage and fruit is limited because of the possibility of phytotoxic effects[2]. In an attempt to learn more about the reasons for this damaging action, we have prepared and tested the following compounds for fungicidal efficiency and phytotoxicity.

2 : 3-*Dichloronaphthahydroquinone*[3] (II). When tested against conidia of *Sclerotinia laxa* Aderh. and Ruhl., this compound showed the same order of activity as the parent quinone, but was no less phytotoxic to tomato foliage and plum fruitlets.

1 : 4-*Diacetoxy*-2 : 3-*dichloronaphthalene*[3] (III). In spore germination tests using (I) and (III) against *S. laxa*, *Botrytis fabæ* Sardiña and *Cladosporium fulvum* Cooke, parallel dosage-response lines were obtained for each organism, suggesting a similar mode of action. Relative potencies given in the

Comparative Toxicity (Molar Basis) of 2 : 3-Dichloronaphthaquinone (I) and 1 : 4-Diacetoxy-2 : 3-Dichloronaphthalene (III)

	ED 50 (I) $\times 10^{-4}$ *M*	*ED* 50 (III) $\times 10^{-4}$ *M*	Rel. potency (I : III)	5% Fid. limits
S. laxa	1·05	1·06	1 : 0·99	0·92–1·07
B. fabæ	2·32	1·11	1 : 2·09	1·92–2·27
C. fulvum	1·15	1·02	1 : 1·13	1·00–1·27
V. inæqualis	1·96	20·1	—	—

accompanying table show that, under the conditions of our tests, the fungistatic activities of (I) and (III) were of the same order on a molar basis. This is significant in view of the absence of the quinonoid structure in (III). In the test using conidia of *Venturia inæqualis* (Cooke) Wint., however, it was not possible to obtain a figure for relative potency since the dosage-response lines were not parallel.

In phytotoxicity trials (I) caused typical damage to the following plants at the concentrations indicated: plum vars. Victoria and Early Laxton (0·05 per cent), tomato var. Market King (0·1 per cent) and broad bean (0·1 per cent). No damage resulted from similar applications of (III) at equivalent concentrations.

2 : 3-*Dichloro*-1 : 4-*dimethoxynaphthalene* (IV). This compound was found to be virtually inactive against all four test fungi. No phytotoxicity was observed on tomato and broad bean plants sprayed with a solution of (IV) equivalent to 0·1 per cent of (I).

Preliminary tests indicate that the acetyl derivatives of pentachlorophenol and 3 : 5-dinitro-*o*-cresol are also appreciably less phytotoxic than the parent phenols, and the toxicity to *S. laxa* is of the same order.

The results of this investigation suggest that esterification may be a useful means of minimizing the phytotoxicity not only of the reduced forms of quinonoid fungicides, but also of other compounds depending on free hydroxyl groups for their fungicidal activity. It is possible that compound (III) is not inherently fungitoxic. We have some evidence that its apparent toxicity may result from its conversion to (II) or (I) by an enzyme produced by the fungus. The differing susceptibilities of the fungi to (III) may be related to their ability to secrete such an enzyme. Work on these lines is proceeding, and a full account will be published elsewhere.

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[2] ter Horst, W. P., and Felix, E. L., *Indust. Eng. Chem.*, **35**, 1255 (1943).
[3] Marsh, R. W., *Nature*, **167**, 97 (1951).
[4] Graebe, C., *Annalen*, **149**, 1 (1869).

Gluco-Corticoid Activity of Deoxycortone Acetate

Early investigations by Ingle[1], Long and collaborators[2], and Reinecke and Kendall[3], showed that deoxycortone acetate lacked glycogenic activity. Olson *et al.*[4] concluded that "neither those steroids which are not ketonic at C_3 and α,β-unsaturated in ring *A* nor those which are without an oxygen substituent at C_{11} have any influence upon carbohydrate and protein metabolism". These findings did not, however, pass unchallenged. Verzár claimed that the difference between deoxycortone acetate and the recognized gluco-corticoids with respect to carbohydrate metabolism was one of velocity, deoxycortone being much slower than the 11-C oxygenated steroids[5–7]. These workers showed that deoxycortone acetate in doses of 2–3 mgm. daily was capable of restoring glycogen production to normal in adrenalectomized rats which were kept alive seven to fourteen days after the operation. However, in short-term experiments in which the animals were sacrificed six hours following the injection of 2·0 mgm. deoxycortone acetate, no evidence of glycogenic activity was obtained.

The present investigation supplies the last and missing link in the above series of experiments. During studies on the conversion of deoxycortone acetate by incubation with adrenal, it was decided to determine whether the deoxycortone acetate itself possessed any gluco-corticoid activity. Ten batches of ten adrenalectomized mice were therefore injected with a total dose per animal of 5·0 mgm. deoxycortone acetate (method of Venning *et al.*[8]) and killed 6½ hr. after the first injection. The mean liver glycogen for each group is presented in the accompanying table. These varied markedly from 8·87 to 71·15 mgm., and gave an overall mean of 33·75 ± 8·09 mgm./100 gm. body-weight. The mean liver glycogen of 211 control adrenalectomized mice was 12·48 ± 1·53 ($P = 0·05$).

Liver Glycogen-levels of Adrenalectomized Mice injected with 5·0 mgm. Deoxycortone Acetate on Day of Test

Group	Number of mice	Liver glycogen per 100-gm. mouse (mean)
a	10	44·78
b	10	53·37
c	10	10·65
d	10	8·87
e	10	71·15
f	10	43·80
g	10	19·30
h	10	19·37
i	10	28·17
j	10	38·10
Total	100	33·756

That this high mean liver glycogen of the deoxycortone acetate group represents a significant difference from that of the control group is shown by the *t* test ($t = 5·81$, $P < 0·001$). On account of the skewed distribution of liver glycogen levels in the deoxycortone acetate as well as in the control group, the *t* test applied to individual values may not be considered valid. Another *t* test was therefore carried out in which the calculation was based on the mean values of batches of ten mice in both groups. The value of *t* obtained was less than the previous figure (4·291), but *P* was still much smaller than 0·001.

The equivalent of this gluco-corticoid activity of deoxycortone acetate in terms of cortisone acetate was calculated from the log-dose regression formula of cortisone acetate ($-145·76 + 129·03\,x$) and the liver glycogen value of 33·75. The corresponding dose of cortisone acetate is 25 μgm. This gives a gluco-corticoid activity for deoxycortone acetate which, though definite, is only 0·5 per cent of that of cortisone acetate.

A hundred adrenalectomized mice injected with a dose of 1 mgm. of deoxycortone acetate gave a mean

of 11·9 mgm./100 gm., which is practically the same as that of the control.

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[1] Ingle, D. J., *Endocrin.*, **27**, 297 (1940).
[2] Long, C. N. H., Katzin, B., and Fry, E. G., *Endocrin.*, **26**, 309 (1940).
[3] Reinecke, R. M., and Kendall, E. C., *Endocrin.*, **32**, 505 (1943).
[4] Olson, R. E., Thayer, S. A., and Kopp, L. J., *Endocrin.*, **35**, 464 (1944).
[5] Sass-Kortsak, A., Wang, F. C., and Verzár, F., *Amer. J. Physiol.*, **159**, 256 (1949).
[6] Venning, E. H., Kazmin, V. E., and Bell, J. C., *Endocrin.*, **38**, 79 (1946).
[7] Wang, F. C., and Verzár, F., *Amer. J. Physiol.*, **159**, 263 (1949).

Formation of 'Heinz Bodies' by a Thiosemicarbazone

The marked suppressive action which *p*-acetylamino-benzal-thiosemicarbazone exerts in experimental tuberculosis as first shown by Domagk[1], and its effect in certain forms of human tuberculosis as reported by Mertens and Bunge[2], make the study of toxic side-effects of this drug an urgent necessity. Although the occurrence of hæmolytic anæmia has been observed clinically[3], no experimental anæmias produced by this drug in laboratory animals have been reported to date. The following observations may give an indication of the type of change which erythrocytes undergo during *p*-acetylamino-benzal-thiosemicarbazone therapy.

Four groups of albino mice, each consisting of ten animals of 16–18 gm. weight, were fed a normal diet into which graded amounts of *p*-acetylamino-benzal-thiosemicarbazone were incorporated, corresponding to 200, 100, 50 and 25 mgm. respectively of drug per 100 gm. feed. At the end of the fourth week, blood films, vitally stained with nile blue sulphate (Grübler's), were prepared from all mice, using blood from the tail vein.

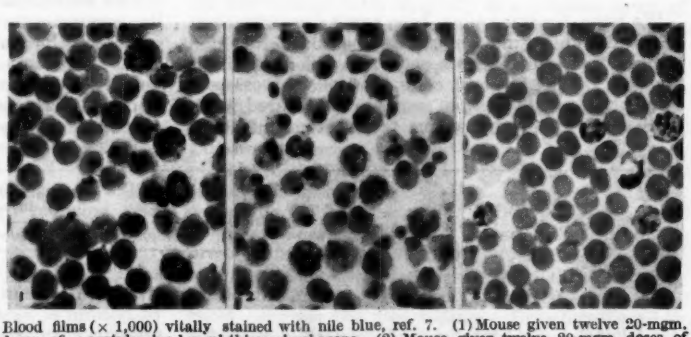
All blood films derived from the mice which received a diet containing 200 mgm. per cent *p*-acetylamino-benzal-thiosemicarbazone showed numerous dark-blue rounded bodies which appeared to be attached to erythrocytes. About one in five of the erythrocytes showed one or, on occasion, two such bodies, the diameter of which measured up to one-quarter of the diameter of the red cell. Similar, but less marked, changes were observed in the case of mice which received a diet containing 100 or 50 mgm. per cent of *p*-acetylamino-benzal-thiosemicarbazone. The blue-staining bodies, though clearly defined, were smaller and fewer in number. Finally, in mice receiving the lowest dosage (25 mgm. per cent) the change was barely noticeable, less than 5 per cent of the erythrocytes showing very small blue bodies attached to their surface.

These globular bodies have the morphological and staining characteristics of so-called 'Heinz bodies', first described by Heinz[3] as occurring in the blood of rabbits treated with phenylhydrazine. The subsequent study of the formation of Heinz bodies as caused by numerous aniline derivatives and other chemical agents was reviewed recently by Webster[4].

When tested by essentially the same technique as described above for *p*-acetylamino-benzal-thiosemicarbazone, neither the 4-hydroxy nor the 4-ethylsulphonyl derivative of benzal-thiosemicarbazone produces Heinz bodies in mice. It appears, therefore, that the tendency of *p*-acetylamino-benzal-thiosemicarbazone to form Heinz bodies is not caused by the thiosemicarbazide moiety of the molecule but may depend upon the nuclear substitution in the benzene ring. The view that the free amino group in the 4-position to the carbonyl group is responsible for the action of *p*-acetylamino-benzal-thiosemicarbazone on erythrocytes is supported by our observation that small single doses of the free 4-amino-benzal-thiosemicarbazone (3–5 mgm. *per os*) are sufficient to produce Heinz bodies in mice, whereas 200 mgm. of the acetylated product (*p*-acetylamino-benzal-thiosemicarbazone) can be given as a single dose without visible effect on the erythrocytes. Only prolonged administration of the drug produces the 'Heinz body' phenomenon.

In preliminary experiments with small groups of mice, consisting of four animals each, *p*-acetylamino-benzal-thiosemicarbazone, *p*-amino-salicylic acid and phenothiazine were compared with regard to their effect on erythrocytes and total hæmoglobin. Phenothiazine, an anthelminthic, was chosen because of its marked tendency to produce hæmolytic anæmia in humans[5] and Heinz body anæmia in mice and in rhesus monkeys[6]. The three drugs, fed by stomach tube in twelve 20-mgm. doses given over an eighteen-day period, had the following effects on the blood examined 24 hr. after the last treatment: *p*-acetylamino-benzal-thiosemicarbazone produced a slight anæmia with an average hæmoglobin concentration of $11{\cdot}42 \pm 0{\cdot}46$ gm. per cent as against $13{\cdot}25 \pm 0{\cdot}31$ gm. for the untreated control group; vitally stained blood films contained numerous Heinz bodies (Fig. 1); with phenothiazine the anæmia was more marked ($8{\cdot}87 \pm 0{\cdot}14$ gm. per cent hæmoglobin), the blood films showing large Heinz bodies attached to all fully developed erythrocytes (Fig. 2); *p*-amino-salicylic acid caused no appreciable anæmia or formation of Heinz bodies, though one mouse died after the seventh treatment. Spectrophotometric examination by means of a Hilger Uvispek spectrophotometer (by courtesy of Dr. R. C. Parker) revealed the presence of methæmoglobin in the blood samples from mice treated with *p*-acetylamino-benzal-thiosemicarbazone and with phenothiazine respectively, but not in the blood from mice treated with *p*-amino-salicylic acid.

Although to date no Heinz body formation has been reported in the blood of patients undergoing



Blood films (× 1,000) vitally stained with nile blue, ref. 7. (1) Mouse given twelve 20-mgm. doses of *p*-acetylamino-benzal-thiosemicarbazone. (2) Mouse given twelve 20-mgm. doses of phenothiazine. (3) Normal mouse

p-acetylamino-benzal-thiosemicarbazone therapy, this type of blood change, detectable by means of vital staining[7], deserves special attention because of its possible value as an early indication of the onset of hæmolytic processes.

It is of interest that *iso*-nicotinyl hydrazide[8], fed to mice in maximum tolerated single doses of 3–4 mgm. per 20 gm., does not cause Heinz body formation.

Heinz body formation in its relation to the potential toxicity of antituberculous agents is being further investigated.

These experiments, in which assistance was given by Mr. W. H. Linklater, are part of an investigation supported by a grant from the National Research Council of Canada. I am also indebted to Mr. G. M. Healy for the photospectrometric recordings, and to Dr. D. E. Seymour, of Herts Pharmaceuticals, Ltd., for supplying the ethyl-sulphonyl-benzal-thiosemicarbazone. The other compounds studied were prepared in our laboratory.

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A. Zubrys
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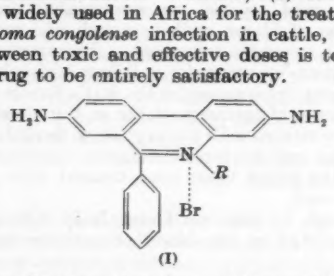
University of Toronto,
Toronto. Oct. 26.

[1] Domagk, G., *Amer. Rev. Tuber.*, **61**, 8 (1950).
[2] Mertens, A., and Bunge, R., *Amer. Rev. Tuber.*, **61**, 20 (1950).
[3] Heinz, R., *Virchows Arch. Path. Anat.*, **122**, 112 (1890).
[4] Webster, S. H., *Blood*, **4**, 479 (1949).
[5] Hubble, D., *Lancet*, **241**, 600 (1941).
[6] Siebenmann, C. O., *Can. J. Pub. Health*, **34**, 47 (1943).
[7] Friedstein, D., *Folia Haemat.*, **12**, 239 (1911).
[8] Grunberg, E., and Schnitzer, R. J., *Quart. Bull. Sea View Hosp.*, **13**, 3 (1952).

Effect of Changing the Quaternizing Group on the Trypanocidal Activity of Dimidium Bromide

Dimidium bromide (2 : 7-diamino-10-methyl-9-phenyl-phenanthridinium bromide) (I, R=CH_3—) has been widely used in Africa for the treatment of *Trypanosoma congolense* infection in cattle, but the ratio between toxic and effective doses is too small for the drug to be entirely satisfactory.



(I)

We have, for some time, been testing modifications of the dimidium molecule, changing the nature and position of substituents on the phenanthridine nucleus. Though many compounds have possessed some trypanocidal action, and some appeared to be more active against laboratory trypanosome infections than was dimidium bromide itself, the most interesting series has been that in which only the quaternizing group of dimidium bromide has been changed. For example, the homologous series in *n*-alkyl compounds may be mentioned; the results in Table 1 show that both the acute toxicity in mice and also the activity against various trypanosome species in mice are profoundly altered by increasing the length of the quaternizing group.

In this table each figure represents the mean of a number of tests. Activity has been compared on the basis of the (curative dose)$_{50}$, activity of dimidium bromide being taken as unity in each test.

Two compounds of this series, *R.D.*1572 (R=—C_2H_5), *R.D.*1427 (R=—C_3H_7) and also *R.D.*1446(R= —CH_2—CH=CH_2), were submitted for field-trial in Africa. In a preliminary test carried out by Mr. J. K. H. Wilde and Mr. J. Robson at the Veterinary Research Department, Mpwapwa, Tanganyika Territory, *R.D.*1572, to which we have given the trivial name 'ethidium bromide', appears to possess considerable promise for the treatment of *T. congolense* infection of zebu cattle, though the ratio of activity between ethidium bromide and dimidium bromide in this test was lower than in the laboratory tests. Results of this preliminary test are shown in Table 2. It should be mentioned that the dose of dimidium bromide normally used in this area is 1·5 mgm./kgm.

Table 2

Drug	Dose (mgm./kgm.)	Proportion of relapses within five months
Dimidium bromide	1·0	1/6
	0·5	4/6
Ethidium bromide	0·9	0/8
	0·3	1/8
	0·1	5/8

Full details of both laboratory experiments on this series of compounds and of field-trials are to be published elsewhere.

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A Rapid Semi-quantitative Spot Test for Reducing Steroids

The resolution of a mixture of corticosteroids into its components by partition chromatography on cellulose columns necessitates the handling of a large number of fractions, owing to the widely differing R_F values of the fastest and the slowest of these compounds. Thus a column made up of 3·5 gm. of powdered cellulose may require as much as 1,000 ml.

Table 1

Compound	Quaternizing group R=	Acute toxicity to mice (LD_{50} mgm./kgm. subcutaneous)	Ratio of therapeutic activity dimidium bromide = 1			
			T. congolense	*T. brucei*	*T. gambiense*	*T. rhodesiense*
Dimidium	—CH_3	85	1	1	1	1
*R.D.*1572	—C_2H_5	110	10	20	50	11
*R.D.*1427	—C_3H_7	110	6	35	40	12
*R.D.*1528	—C_4H_9	65	3	6	8	8
*R.D.*1602	—C_5H_{11}	125	1	3	3	1
*R.D.*1470	—C_6H_{13}	80	0·6	1	1	1

of solvent (toluene/propylene glycol) to elute compound *F*. It is therefore desirable, prior to the working up of the individual fractions, to have an idea of their likely steroid content and to eliminate those not containing any active material.

A test has been developed which is based on the reducing properties of the suprarenal steroids and which enables a rapid estimate to be made of the approximate steroid content of each fraction. Since the conjugation at C_3–C_4, as well as the ketol group, has reducing properties under the experimental conditions employed, any steroid with this structure will give a positive reaction. The same is true of other reducing compounds which may be present in suprarenal extracts and which happen to have R_F values intermediate between those of compounds *A* and *F*. Thus the test is not specific for cortical steroid hormones.

The test is carried out as follows. An aliquot of the fraction is evaporated in a stream of air. The residue (mainly propylene glycol) is dissolved in one drop of ethanol, followed by two drops of chloroform. The solution so obtained is applied by means of a capillary to a strip of Whatman No. 1 paper, 1 cm. wide and of sufficient length to accommodate as many aliquots as is desired to test in one operation. A stream of air is directed at the point of application to aid evaporation of the solvent, the solution being applied at such a rate as to limit the circle to a diameter of about 7 mm. The container is rinsed with another two drops of chloroform which are transferred to the strip as before. When the latter appears dry, it is placed with one long edge in arsenomolybdate reagent previously streaked along a glass plate, allowing the reagent to rise across the strip. The other edge is then lowered on to the plate, any air bubbles being squeezed out with a glass rod. More reagent can then be run along this edge, if necessary. This procedure ensures even wetting and prevents lateral displacement of the test spots by reagent running along the strip. The paper is covered with another glass plate previously warmed to 65° and is then incubated at that temperature for 30 min. At the end of this period the cover plate is removed and the strip is allowed to dry in the air. The blue colour of the test spot is then compared with suitable standards prepared simultaneously.

The reagent used is that of Nelson[1] and is prepared as follows: a solution of 25 gm. of ammonium molybdate in 450 ml. of water is mixed with 21 ml. of concentrated sulphuric acid, and a solution of 3 gm. of $Na_2HAsO_4.7H_2O$ in 25 ml. of water is added. The mixture is incubated at 37° C. for 48 hr. and filtered. It is stored in a glass-stoppered brown bottle.

The paper strip, which gradually goes blue on keeping for several hours, can be preserved by immersing it quickly in a 5 per cent solution of ammonium citrate and allowing it to dry on a glass plate. Excess reagent is thereby destroyed.

The small amount of propylene glycol remaining on the strip does not reduce the reagent under the experimental conditions described and does not materially inhibit the oxidation of steroids. The filter paper itself is only very weakly reducing, and hence the blue spots appear on a greenish-yellow background.

The test described above is very sensitive. Thus deoxycorticosterone can be detected in amounts down to 0·5 μgm. if the diameter of the spot is limited to 7–9 mm., that is, 1 μgm./cm.². Other corticosteroids are slightly less reducing.

The reaction with arsenomolybdate can be used for the location of reducing steroids on paper chromatograms and is more sensitive than the reagents normally employed. Moreover, the reaction is quantitative and the blue complex, which is stable for several days, can be eluted and determined colorimetrically. This enables individual steroids, as separated by chromatography, to be evaluated quantitatively. Work on this method is at present being completed and will be published elsewhere.

My thanks are due to the directors of Messrs. Allen and Hanburys, Ltd., for permission to publish this communication.

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Ware, Herts.
Oct. 23.

[1] Nelson, N., *J. Biol. Chem.*, **153**, 375 (1944).

An Asian Banana (*Musa acuminata*) in Pemba, Zanzibar Protectorate

Musa acuminata Colla is normally understood to be an Assam species which ranges, in one of its many forms, from north-eastern India, through Indo-China, Malaya and the Archipelago, to Queensland and Polynesia[1]. It is therefore of interest to record its presence, on the other side of the Indian Ocean, in Pemba, Zanzibar Protectorate. Specimens were examined by Baker and Simmonds in 1948 in Zanzibar, bunches having been sent over from Pemba through the good offices of the Department of Agriculture. Five bunches were examined from three localities, namely, Funzi Island, the Ngezi forest and Wete. Plants raised from seed from all three localities have been under study at this College, and the following remarks are based upon them.

All three collections are undoubtedly *Musa acuminata*, and, phenotypically, resemble the Selangor form of the species[1]. Fourteen plants have been examined cytologically, and of them four were heterozygous for inversion; others showed occasional bridges without fragments (presumably due to small inversions or stickiness); and some showed a variable amount of failure of pairing, which, however, rarely affected more than one bivalent per nucleus. A certain amount of pollen sterility appeared to be associated with some morphological abnormality of male flowers, though doubtless partially due to failure of chromosome pairing. A search was made for interchange heterozygosity as a possible cause of male sterility; but no certain multivalents were seen in the many scores of cells examined.

Pollination experiments[2] have shown that the Wete introduction is but distantly related to the Selangor, Tavoy, Annam and Mariani forms of *M. acuminata*; its nearest relative appeared to be the Buitenzorg form, to which it bears, however, little phenotypic resemblance.

There is no evidence of the occurrence of *Musa acuminata* on Zanzibar itself, though there is a suitable habitat in the Jozani forest[2]. Therefore, its presence in the neighbouring Pemba raises an interesting phytogeographical problem, in that there are considerable geological, faunistic and floristic differences between the two islands. Broadly, Zanzibar is African in geological origins and biological affinities, having been separated from the continent of Africa

by a shallow sea since Pliocene times. Pemba, by contrast, has been separated from both Africa and Zanzibar since Miocene times by rift-faulting, and it has distinctly Indo-Malayan biological affinities[4]. It is tempting, therefore, to regard *M. acuminata* as long native to Pemba, and this view would find confirmation in the discovery that it was genetically and cytologically distinct from other forms of the species. An alternative view (which would be supported by the discovery that it had near Asian relatives) is that it is a comparatively recent introduction, presumably at the hands of Arab travellers about a thousand years ago. But why a seeded banana should be carried across the Indian Ocean, and why, if that did happen, the species is not also present in Zanzibar and the neighbouring continental coast (for example, the lower Usambara hills) is not obvious. There evidently is here an extremely interesting phytogeographical and evolutionary problem.

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K. Shepherd

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Imperial College of Tropical Agriculture,
Trinidad.
Oct. 27.

[1] Cheesman, E. E., *Kew Bull.*, 17 (1948).
[2] Simmonds, N. W., *J. Genet.* (in the press).
[3] Tidbury, G. F. (personal communication).
[4] Stockley, G. M., Report on the Geology of the Zanzibar Protectorate (Zanzibar, 1928).

Occurrence of *Fucus inflatus* L. forma *distichus* (L.) Börgesen on the North Coast of Scotland

While carrying out an ecological survey of the north coast of Scotland during the summer of 1951, *Fucus inflatus* L. forma *distichus* (L.) Börgesen[1] was found along part of the north coast of Caithness. This subarctic species has not been recorded previously for the mainland of Britain.

In the north-east Atlantic area, *F. inflatus* is recorded from Iceland, Norway, Sweden, the Faeroes and the Shetlands; it is not recorded, however, from the Orkneys. Lund[2] has reported a recent immigration of a larger form of the species (*F. inflatus* L. f. *edentatus* (De la Pyl.) Rosenv.) into Danish waters; this form was not found anywhere on the north coast of Scotland.

In Caithness, *F. inflatus* f. *distichus* was found from a point three miles west of Holborn Head (near Thurso), westwards for about twelve miles only, to near the county boundary. It is restricted to very exposed, steep (30°–50° slope) reefs of Caithness flagstone, facing north-west or north. The range may extend slightly farther, both east and west, on similar reefs that are difficult to reach. On the most exposed reefs *F. inflatus* is often the only fucoid present and forms a distinct community (6 in.–18 in. vertical range) coincident with the upper limit of barnacles. With slightly less exposure the following two fucoids may be found, above and below the *F. inflatus* zone, respectively: (i) *F. spiralis* L. f. *nana* Kjellm., a dwarf form produced by severe exposure conditions; Börgesen[1] has described a similar 'eco-form' from the Faeröes; (ii) *F. vesiculosus* L. var. *evesiculosus* Cotton, a sturdy evesiculate variety found commonly on exposed British coasts.

F. inflatus f. *distichus* is very well adapted for survival in habitats subjected to constant heavy surf. Good descriptions are given by Börgesen[1] and Printz[3]; but the Caithness plants are rather larger than those described by these authors. The plants are short and sturdy, usually 8–14 cm. in length, but with occasional fertile specimens up to 20 cm. long. The holdfast may be as much as 2 cm. in diameter and is attached very firmly to the rock; the stipe is short and thick and stands erect, and the distal branches arch over very characteristically. The thallus is narrow, entire and evesiculate, seldom more and usually less than 4 mm. wide, decreasing in width upwards, and consisting mainly of a stout midrib with very narrow lateral wings. The receptacles are typically terminal, linear, narrow and acuminate, round in section, undivided, usually 15–25 mm. long and 2–3 mm. broad, but occasionally up to 40 mm. long and 4 mm. broad. This species is hermaphrodite (monœcious), and during the first half of July was fruiting abundantly; by the end of August fruiting had virtually ceased.

Apart from Börgesen's[4] well-known record of the form *edentatus* at Lerwick (Shetland Isles), recent search has disclosed the following additional old records of *F. inflatus* from various parts of the British Isles: (1) fertile specimens of genuine *F. inflatus* f. *distichus*, collected during April and May 1909 from the Island of Lewis, have been located in the Kew Herbarium (the fruiting period in Britain therefore appears to extend at least from the beginning of April to the end of July); (2) examination of old herbarium specimens of *Fucus anceps* Harv. and Ward, only recorded from Kilkee, Co. Clare, Eire (see Carruthers[5]), entirely confirms Börgesen's opinion (ref. 1, p. 725) that this small fucoid is simply a form of *F. inflatus* f. *distichus*; (3) Traill[6] records a single specimen of "*Fucus distichus* L." cast ashore in the Firth of Forth in 1882; unsuccessful efforts have been made to trace this doubtful specimen.

These confirmed records from Lewis and Kilkee suggest that *F. inflatus* f. *distichus* may be fairly widespread on exposed northern and western coasts of the British Isles. The rather restricted range on the north coast of Scotland suggests that the species may have become established there relatively recently; but, since the area has not been investigated critically before, the matter must remain in doubt.

We are indebted to several colleagues, especially Miss C. I. Dickinson, Herbarium, Kew, and Miss L. M. Newton, British Museum, for assistance in tracing herbarium specimens.

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Isle of Cumbrae.

J. R. Lewis
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University College of Wales,
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Oct. 25.

[1] Börgesen, F., "Botany of the Faeröes", **2**, 339 (1903); **3**, 683 (1905–8).
[2] Lund, S., *Nature*, **164**, 616 (1949).
[3] Printz, H., *Skr. norske Vidensk.-Akad. Oslo* (1926).
[4] Börgesen, F., *J. Bot.*, **41**, 300 (1903).
[5] Carruthers, W., *J. Bot.*, **1**, 353 (1863); **2**, 54 (1864).
[6] Traill, G. W., "A Monograph of the Algæ of the Firth of Forth" (Edinburgh, 1885).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 24

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Informal Lecture on "Radio-Controlled Models".

SOCIETY FOR ENDOCRINOLOGY (in the Barnes Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 5.30 p.m.—Dr. Dwight Ingle: "The Role of the Adrenal Cortex in Homeostasis".*

INSTITUTE OF METALS (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Dr. J. J. P. Staudinger: "The Place of Plastics in the Order of Matter" (1952 May Lecture).*

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Commander C. J. W. Simpson: "Explorations in Queen Louise Land".

Monday, March 24—Thursday, March 27

ERGONOMICS RESEARCH SOCIETY (at the College of Aeronautics, Cranfield, Bletchley, Bucks).—Symposium on "Fatigue".

Tuesday, March 25

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. B. H. Farmer: "Colonisation in the Dry Zone of Ceylon".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—Miss E. M. J. Campbell: "Ten Days in a Maori Pa".

SOCIETY OF INSTRUMENT TECHNOLOGY (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. F. R. Axworthy: "The Design and Application of a Portable Electrostatic Watt Meter".

Tuesday, March 25—Thursday, March 27

INSTITUTE OF METALS (at Park Lane Hotel, Piccadilly, London, W.1).—Annual General Meeting; Symposium on "Equipment for the Thermal Treatment of Non-Ferrous Metals and Alloys".

Wednesday, March 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Prof. A. J. Sims: "The Rolling of Ships" (Thomas Gray Lecture).

PHYSICAL SOCIETY, COLOUR GROUP (at the Royal Photographic Society, Prince's Gate, London, S.W.7), at 3 p.m.—Annual General Meeting; at 3.15 p.m.—Mr. R. W. G. Hunt: "The Subjective Appraisal of Colour Photographs"; Mr. R. G. Horner: "The Visual Interpretation of Characteristic Curves in Colour Photography".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. C. T. Saunders: "Consumption of Raw Materials in the United Kingdom, 1815–1950".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. C. C. Hall and Mr. S. L. Smith: "Comparison of the Fixed Bed, Liquid-Phase 'Slurry', and Fluidized Bed Techniques in the Fischer-Tropsch Synthesis".*

INSTITUTE OF RURAL LIFE AT HOME AND OVERSEAS (at 84 Eccleston Square, London, S.W.1), at 5.30 p.m.—Mr. G. W. Nye: "Some Problems and Recent Developments in Colonial Agriculture".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6 p.m.—Annual General Meeting; at 6.15 p.m.—Dr. P. F. Fraser: "Wine Diseases and Condition Troubles—their Prevention and Cure".

WOOL EDUCATION SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7 p.m.—Dr. E. G. Carter: "Science in the Service of Wool".

Thursday, March 27

ROYAL INSTITUTE OF CHEMISTRY, MANCHESTER SECTION (joint meeting with the CHEMICAL SOCIETY, the SOCIETY OF CHEMISTRY AND INDUSTRY and the INSTITUTE OF PETROLEUM, in the large Chemistry Lecture Theatre, The University, Manchester), at 10 a.m.—Symposium on "The Principles and Applications of Ion Exchange".*

ASLIB, NORTHERN BRANCH (in the Lecture Room, Central Library, Sheffield), at 10.30 a.m.—Messrs. G. H. Davison, J. R. Smith and E. B. Smith: Symposium on the "Working of a Public Technical", a "Government" and an "Industrial Library"; at 2.30 p.m.—Mr. P. A. Nash: "Technical Information Services".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. D. Gabor: "Wave Theory of Plasmas"; Prof. G. C. McVittie: "A Model Universe admitting the Interchangeability of Stress and Mass".

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Society for Visiting Scientists, 5 Old Burlington Street, London, W.1), at 5 p.m.—Discussion on "Sound Absorption" (to be opened by Mr. H. Creighton, Mr. E. J. Evans and Mr. H. R. Humphreys).

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Field for College Laboratory Experiments on Modern Magnetic Materials" (to be opened by Dr. L. G. A. Sims).

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. H. M. Gale: "The Application of Magnetic Amplifiers to Industrial Measurement and Control".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. D. R. Newman: "Some Aspects of Civil Jet Aircraft Performance".

SOCIETY OF DYERS AND COLOURISTS, WEST RIDING SECTION (at the Great Northern Victoria Hotel, Bradford), at 7.15 p.m.—Annual General Meeting.

CHADWICK PUBLIC LECTURE (in the Lecture Hall, Public Library, Chesterfield), at 7.30 p.m.—Prof. S. E. Finer: "Public Health—a Comparison between the Age of Chadwick and our Own".*

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. F. A. Paneth, F.R.S.: "The Chemical Exploration of the Stratosphere" (Hugo Müller Lecture). (To be repeated at 6.30 p.m. on Wednesday, April 23, in the Chemistry Lecture Theatre, The University, Manchester.)

Thursday, March 27—Friday, March 28

BRITISH PAPER AND BOARD MAKERS' ASSOCIATION, TECHNICAL SECTION (at Manson House, 26 Portland Place, London, W.1).—Conference on "Fibrous Materials for Papermaking—the Present Position and Future Outlook".

Thursday, March 27—Saturday, March 29

NATIONAL ASSOCIATION FOR MENTAL HEALTH (at Bedford College for Women, Regent's Park, London, N.W.1), at 10 a.m. each day.—Annual Conference on "The Mentally Handicapped in the Community".

Thursday, March 27—Monday, March 31

BRITISH PSYCHOLOGICAL SOCIETY (at Oxford).—Annual General Meeting.

Friday, March 28

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at Radiant House, Bold Street, Liverpool), at 2.30 p.m.—Dr. E. G. Ritchie: "Research into Steam and Heat Utilisation in Industry".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Dr. R. Theile: "The Mechanism of Signal Generation in Storage Type Picture Tubes".

WOLVERHAMPTON SOCIETY OF APPLIED SCIENCE (at the Technical College, Wolverhampton), at 7.30 p.m.—Dr. J. M. Pirie: "Some Industrial Uses of the Noble Metals".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Lawrence Bragg, F.R.S.: "The Cavendish Laboratory Archives".

Friday, March 28—Saturday, March 29

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS (at the Royal Horticultural Society's New Hall, Greycoat Street, London, S.W.1), at 10 a.m. each day.—First Electrical Engineers Exhibition.

BRITISH SOCIETY OF RHEOLOGY (in the Chemistry Lecture Theatre, The University, Sheffield).—Symposium on "Emulsions and Films".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE CHEMISTRY DEPARTMENT—The Principal, Dundee Technical College, Dundee (March 28).

ASSISTANT (with good honours degree in physics, or its equivalent, plus industrial research and/or teaching experience) to teach PHYSICS, with some MATHEMATICS, at the Technical College of Monmouthshire, Crumlin—The Director of Education, County Hall, Newport, Mon. (March 29).

HONOURS GRADUATE IN PHYSICS, to teach physics up to G.C. of education (advanced and scholarship) standard, together with some mathematics to advanced students—The Principal, Gloucester Technical College, Brunswick Road, Gloucester (March 29).

RESEARCH APPOINTMENTS (2, temporary) IN ELECTRON PHYSICS, as members of a research group dealing with the electronic properties of semi-conductors and microwave electronics—Prof. J. Sayers, The University, Edgbaston, Birmingham 15 (March 29).

SUPERINTENDING SCIENTIST, Melbourne (with an honours degree in one of the physical sciences or mathematics, with at least five years research experience), as Scientific Adviser to the Military Board, Department of the Army—The Senior Representative, Department of Defence Production, Canberra House, 87 Jermyn Street, London, S.W.1 (March 29).

SUPERVISING ENGINEER (with a university degree, or equivalent qualifications, preferably in mechanical engineering, and some knowledge of electrical engineering) in the Aeronautical Research Laboratories, Melbourne, to be responsible for the design, construction, installation and maintenance of the plant and mechanical and electrical equipment used for aeronautical research such as wind tunnels, structural testing machines, air compressors, etc.—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (March 29).

ASSISTANTS IN THE DEPARTMENT OF CHEMISTRY, University College, Dundee (one to specialize in organic chemistry and one in physical or inorganic chemistry)—The Secretary, The University, St. Andrews (March 31).

LECTURER IN APPLIED CHEMISTRY (with special qualifications in analytical chemistry, including macro- and micro-analysis)—The Registrar, College of Technology, Manchester 1 (March 31).

UNIVERSITY LECTURER IN BOTANY—Dr. S. Smith, Department of Zoology, Downing Street, Cambridge (April 1).

SPECIALIST ADVISORY OFFICERS (with a degree in an appropriate science) in soil chemistry, the chemistry of animal nutrition, entomology, plant pathology and bacteriology; ASSISTANTS to the Officers referred to above, on field and laboratory work; and CHEMISTS (with a degree in chemistry, or its equivalent) for analytical work on soils, feeding stuffs and other agricultural materials; in the National Agricultural Advisory Service—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 129/52 (April 3).

ASSISTANT PHYSICIST (with an honours degree in physics)—The Secretary to the Board of Governors, Royal Free Hospital, Gray's Inn Road, London, W.C.1 (April 5).

COAL SURVEY OFFICERS (with a good honours degree or equivalent in a science subject, preferably with a sound background in geology and chemistry) in the Central Fife and Lothians areas—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/445 (April 12).

SENIOR ELECTRONIC ENGINEER at the Central Research Establishment, Stoke Orchard, Cheltenham, to undertake the design and provision of electronic devices as required for research—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/439 (April 12).

LECTURER IN AGRICULTURAL ZOOLOGY—The Secretary, The University, Aberdeen (April 15).

ASSISTANT LECTURER (with an honours or special degree in zoology) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (April 18).

LECTURERS OR ASSISTANT LECTURERS IN BOTANY (candidates should have special interests in either plant physiology or morphology and systematics) at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (April 19).

RESEARCH OFFICER (Physicist) (with a university honours degree in science, or equivalent, with physics as major subject) in the Wool Textile Research Laboratory, Geelong, to carry out research on woollen and worsted carding—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Ref. 3787 (April 19).

CHAIR OF METEOROLOGY at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 21).

PLANT GENETICIST (Principal Scientific Officer or Senior Scientific Officer grade) (with a good honours degree in botany or agricultural botany, and special knowledge of plant breeding and genetics) in the grass breeding section—The Registrar, Welsh Plant Breeding Station, Aberystwyth (April 26).

DIRECTOR OF THE INSTITUTE FOR RESEARCH IN AGRICULTURAL ECONOMICS—The Registrar, University Registry, Oxford (May 3).

RESEARCH FELLOWSHIPS for independent research—The Registrar, The University, Reading (May 3).

DEAN SCHOLARSHIPS for research on a subject related to the history and economics of the wool textile industry—The Head of the Department of Economics and Commerce, The University, Leeds 2 (June 1).

COKE RESEARCH FELLOWSHIP for research in the Department of Fuel Technology, and ELLISON RESEARCH FELLOWSHIPS for research in chemistry or physics—The Registrar, The University, Sheffield (June 12).

AGRONOMIST AT THE WEST AFRICAN CACAO RESEARCH INSTITUTE, Gold Coast, to assist in laying down field experiments on various methods of cultivating cocoa—The Under-Secretary of State, Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

ASSISTANT (Grade B) FOR BIOLOGY, and a MECHANICAL ENGINEERING ASSISTANT (Grade B) at the Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

ASSISTANT ENGINEERS (ELECTRICAL)—The Clerk, Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1, quoting Ref. F.

ASSISTANT EXPERIMENTAL OFFICER, to work as an assistant on genetical experiments in plants and drosophila—The Secretary, John Innes Horticultural Institution, Bayfordbury, Hertford.

ASSISTANT GROUP MANAGER (with an honours degree in physics or chemistry, associateship of the Inst. of Physics or the R.I.C., or equivalent qualifications) IN THE HEALTH PHYSICS AND SAFETY GROUP at Windscale Works, Sellafield, Cumberland—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs., quoting Ref. 310.

ASSISTANT LECTURER IN PHARMACEUTICS—The Secretary, Royal Technical College, Glasgow.

BIOCHEMIST (with a degree in biochemistry, or equivalent, and a good knowledge of hospital work or of physiology) for Area Laboratory—The Secretary, Westwood Hospital, Beverley, Yorks.

CHEMISTS for work involving the flowsheeting of chemical processes from chemical and chemical engineering research and development data, and advising on details during the design of production plants—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 309.

CHIEF OFFICER OF THE OFFICIAL SEED TESTING STATION FOR ENGLAND AND WALES, a CHIEF OFFICER FOR HORTICULTURAL TRIALS AND PROPAGATIONS, a CHIEF ASSISTANT FOR POTATO INVESTIGATIONS, SENIOR TECHNICAL OFFICERS (one mainly for herbage crops and the other mainly for cereals), and TECHNICAL ASSISTANTS IN SEED PRODUCTION—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

ELECTRONICS OFFICER (thoroughly familiar with and capable of establishing and taking charge of a radio-sonde/radar-wind station at Khartoum, using equipment of the type currently used by the British Meteorological Office) in the Sudan Meteorological Service—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Electronics Officer 4/1710'.

IRRIGATION ENGINEERS IN THE PUBLIC WORKS DEPARTMENT, North Borneo—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27322/68.

MATHEMATICIAN or MATHEMATICAL PHYSICIST (with a good honours degree and, preferably, some knowledge of the theory of elasticity) for research in applied mechanics—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

METALLURGISTS (one with electrical knowledge and experience of instrumentation methods, for team investigating fusion welding of light alloys, and another with L.I.M. qualification, or some metallurgical experience, for team investigating arc welding of alloy steels)—The Secretary, British Welding Research Association, 29 Park Crescent, London, W.1.

PHYSICAL CHEMIST (degree in chemistry essential, and some research experience in electrochemistry or corrosion an advantage) for research in the Electrochemistry Section of the Laboratories at Sketty Hall, Swansea—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

PHYSICISTS at a Ministry of Supply Research Establishment in Cambridgeshire—SENIOR SCIENTIFIC OFFICERS: (*a*) (Ref. A.51/52A) with some engineering or metallurgical experience, for investigations of a fundamental nature relating to armour penetration problems; (*b*) (Ref. A. 52/52A) with mathematical ability and some knowledge of thermodynamics, for work on the mechanism of damage by small calibre shell, and SCIENTIFIC OFFICERS (Ref. A. 53/52A) with experience of electronics, for work in connexion with high-speed photography—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

SCHOLARSHIPS IN TEXTILE TECHNOLOGY, TEXTILE ENGINEERING, TEXTILE CHEMISTRY, or DYEING—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

SCIENCE GRADUATE (interested in biology and medicine, with sound training in chemistry) for biochemical analysis and research—The Secretary, Medical Research Council Department of Experimental Medicine, The University, Cambridge.

SENIOR GEOGRAPHER (with a good honours degree in geography with surveying at an advanced standard and preferably with physical geography or geomorphology as a subsidiary subject, and with several years practical experience or several years postgraduate work) in the Soil and Land Use Survey Department, Gold Coast, to carry out topographical survey work in connexion with soil surveys, soil conservation schemes and irrigation projects, etc.—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27059/310.

SENIOR LECTURER IN PHYSIOLOGY (to undertake work at degree level in the Department of Pharmacy) at the Technical College, Bradford—The Director of Education, Town Hall, Bradford.

SENIOR RESEARCH STUDENTSHIP IN ENGINEERING—The Registrar, University College, Singleton Park, Swansea.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Second Report of the Local Government Manpower Committee. (Cmd. 8421.) Pp. ii+54. (London: H.M. Stationery Office, 1951.) 1*s.* 6*d.* net. [1912

Agricultural Research Council. Report Series No. 11: The Nature of Fowl Nephritis. By W. G. Spector. Pp. iii+16+20 plates. (London: H.M. Stationery Office, 1951.) 3*s.* 6*d.* net. [1912

Imperial Forestry Institute. Institute Paper No. 28: The Grass, Fern and Savannah Lands of Ceylon: their Nature and Ecological Significance. By Dr. C. H. Holmes. Pp. 95+13 plates. (Oxford: Imperial Forestry Institute, 1951.) 20*s.* [1912

National Parks and Access to the Countryside Act, 1949. Second Report of the National Parks Commission for the Year ending 30th September 1951. Pp. iv+24. (London: H.M. Stationery Office, 1951.) 2*s.* net. [1912

Abstracts of Dissertations approved for the Ph.D., M.Sc. and M.Litt. Degrees in the University of Cambridge during the Academical Year 1949–1950. (Published by authority.) Pp. 248. (Cambridge: At the University Press, 1951.) [1912

Bee Research Association Handbook. Pp. 12. (London: Bee Research Association, 1951.) 6*d.* [2012

Ovaltine Research Laboratories. Annual Report, 1950. Pp. 9. (London: A. Wander, Ltd., 1951.) [2012

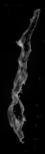
Department of Scientific and Industrial Research. Report of the Radio Research Board with the Report of the Director of Radio Research for the Year 1950. Pp. iv+52. (London: H.M. Stationery Office, 1951.) 1*s.* 9*d.* net. [2012

Other Countries

Publications de l'Institut Français d'Archéologie Orientale du Caire. Etudes Sud-Arabiques, Tome 1: Les monuments de Ma'in (Yemen). Par Mohammed Tawfik. Pp. xii+40 plates+44. (Le Caire: Institut Français d'Archéologie Orientale, 1951.) [81

Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälle. Reports of the Swedish Deep-Sea Expedition, 1947–1948. Edited by Hans Pettersson. Vol. 2: Zoology, Fasc. 1. Pp. 148+2 plates. 25 kr. Vol. 3: Physics and Chemistry, Fasc. 1. Pp. 70+1 plate. 15 kr. (Göteborg: Elanders Boktryckeri A.-B., 1951.) [81

Indian Council of Agricultural Research. Bulletin No. 70: Standard Methods for the Examination and Analysis of Milk and Milk Products other than *Ghee*. Pp. v+39. (Delhi: Manager of Publications, 1951.) 3.8 rupees; 5*s.* 6*d.* [81

British Guiana. Report on the Geological Survey Department for the Year 1950. Pp. iv+78. (Georgetown: Geological Survey Department, 1951.) 1 dollar; 4*s.* 2*d.* [81

East African Meteorological Department. Memoirs, Vol. 2, No. 9: Report on Experiments at Kongwa on Artificial Stimulation of Rain, January–April 1951. By D. A. Davies, D. Hepburn and Dr. H. W. Sansom. Pp. 32+8 plates. (Nairobi: East African Meteorological Department. 1951.) 5*s.* [81